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POWER

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VOLUME L

July 1 to December 31, 1919

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July 1 to December 31, 1919

EXPLANATORY NOTE

Illustrated articles are marked with an asterisk (*), book notices with a dagger (†), inquiries with a double dagger (‡). The cross-references condense the material and assist the reader, but are not to be regarded as complete or conclusive. So, if there were a reference from "Boiler" to "Stoker," and if the searcher failed to find the required article under the latter word, be should look through the "Boiler" entries, or others that the topic might suggest, as he would have done bad there been no cross-reference. Letters are indexed under title or subject, general articles under writer's name as well. Not all articles relating to a given topic necessarily appear under the same entries.

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POWER

Volume 50 New York, July 1, 1919 *Number* 1

His Farewell Advice

In a certain power station was an old gray-haired engineer, who by close application to his job had slowly worked up to the position of Turn Chief. He was a fine old man, one in whom the young engineer soon found a friend, and of a quiet, unassuming manner that commanded respect. He was, in fact, a "dad" to all the youngsters in the service.

There was a genuine feeling of regret, therefore, when a notice appeared on the bulletin board stating that Mr. Blank would assume the duties of Turn Chief and that the old engineer would be pensioned. During the noon-hour, after lunch was over, the crew congregated around the old chief, and one of them let fall a question.

"Chief," said he, "what would you do to win success if you could by magic start all over again in power-station work? In other words, what would be your motto for the apprentice in this line?" The old chief removed his glasses, carefully placed them in their case and pondered a moment before he attempted to answer.

"Well, boys," he remarked, "lack of concentration is to blame for many a failure. I mean that you have to be conscientious in your effort to learn your trade. You have to be positive that you are making the kind of progress that will get results. You cannot guess at your progress—you have to be sure. None of you would attempt to set the valves on your engines without the aid of an indicator; so to be absolutely sure that you are obtaining the desired results in your effort to attain efficiency as an engineer, suppose you use your indicator—your own conscience. Be honest with yourself—take a few cards and find out for certain whether your results are consistent with your ambition.

"It doesn't pay to do a thing by halves, no matter if it is only the repair of a leaky joint on a small steam pipe. Concentrated action is the cure-all—it saves doing it over again tomorrow

"I recall an incident that occurred when I was still young in this business. My stock in trade consisted of about ninety per cent. conceit and ten per cent. adaptability. Like most of the fellows of my age, I took the world as a big joke. Along about that time a world-famous prize fight was pulled off, and incidentally I was much interested. The next day after the big mill the chief engineer told me to go over the valves on a large Corliss engine and to make any changes necessary.

"Now it was the duty of the regular operating engineer to assist me on such work. We put on the indicator rigging, but during our preparations we got into an argument about the prize fight. The relative merits of the two fighters absorbed our minds to such an extent that we argued all the time we worked on that unit. So, by noon we had discussed the fight pro and con and also had completed the work on the engine.

"We got a set of cards that we thought would make the chief take notice—and they did! He went up in the air and came down all over us, the more so when the switchboard operator called attention to the fact that the engine was gradually losing her load. We hadn't indicated the steam engine as much as we had indicated the prize fight, with the result that we left some locknuts loose, and the link-rods nearly wrecked the engine when they fell apart. If there was any reason for our fool conduct, it was conceit, for we had indicated that engine so often that we could do it with our eyes shut—which was exactly what we did. We were both blind to the value of concentration.

"You must bear in mind that it is often the minute details, properly taken care of, that make your record. Concentrate your effort—either mental or physical—along one line. While I have no grievance against the world, lack of concentration is one of the big reasons why I was so long in climbing up the hill. I was much older than most of you fellows when it dawned on me to wake up and take an inventory. I did, with the result that I put more real purpose into my work. And along about that same time the 'bosses' began to put confidence in me. Mottoes are going out of fashion, it seems. But if you want a first-class slogan—you young lads who have the entire fight ahead of you—here it is: ***Concentrate!***"

Contributed by JAMES J. JAHOBART

New Power Plant for St. Mary's Training School

A small plant of varied service well adapted to the requirements of the institution. Moving some of the equipment from the old to the new plant while maintaining service was the source of numerous difficulties. Revamping the water supply made an interesting problem.

ST. MARY'S Training School, one of the largest Catholic institutions in the West, offers a home for a thousand small unfortunates, giving them the advantages of healthy living conditions, coupled with moral and mental training. The institution is beautifully situated overlooking the river at Des Plaines, Ill.

The larger boys are instructed in useful work, tilling the ground and harvesting the crops. The children are given industrial training in housework, sewing, manual training, shoemaking, printing and many other useful lines of endeavor. As the maintenance of healthy housing and living conditions is a necessity in an institution of this kind, particular care and attention was given to the various mechanical services related to the power plant. As in the case of many institutions where the growth has been rapid, the power-plant equipment had become antiquated and inadequate. The machinery had been badly used on account of continual overload and lack of proper relays. After an investigation of plant conditions made in May, 1916, it was decided to build an entirely new plant. As the old building was not suitable for the new equipment and the old apparatus had to be kept in continuous service, a new location was selected.

In the old plant there were four 72-in. x 18-ft. tubular boilers with hand-fired furnaces and shaking grates, operated at 110 lb. pressure. They were in bad condition on account of the use of poor water during the period prior to the installation of a water-softening plant. The generating equipment comprised two high-speed engines directly connected to 75-kw. 125-volt direct-current generators. All power and light distribution for the institution was at 120 volts. The refrigerating system was served by an ammonia compressor having an ice-making capacity of 12 tons. The brine was circulated throughout the service building for refrigerators and ice making.

Much of the heating was effected by forced hot-water circulation. Two heaters were installed to care for this service—an exhaust-steam heater approximately 8 ft. in diameter by 22 ft. high, equipped with iron tubes, and a high-pressure heater 6 ft. in diameter by 15 ft. high. Two turbine-driven centrifugal pumps, each having a capacity sufficient to serve 35,000 sq.ft. of radiation, were used to circulate the hot water. The chapel, convent and power-house group of buildings were on a vacuum system containing approximately 6500 sq.ft. of radiation. Two 5 & 6 x 10-in. vacuum pumps handled the returns.

Water softening by the cold intermittent process was effected by a softener consisting of four wooden tanks, 15 ft. in diameter by 12 ft. high, with two sludge filters 4 ft. in diameter by 4½ ft. high. A 7½ & 5 x 6-in. duplex pump transferred the water from the softener to the treated-water tank in a brick tower adjoining the boiler room. From this tower treated water was distributed to the laundry, hot-water heaters for domestic service and to the feed-water heater for boiler-feed service. A 6 & 4 x 6-in. duplex pump circulated the domestic hot water, and two direct-acting pumps in connection with an open feed-water heater were used for boiler-feed service. A straight-line steam-driven air compressor having a displacement of approximately 150 cu.ft. of air per minute provided air at 45 lb. pressure for lifting the drinking water from a driven well and delivering it to a direct-acting pump, by which it was circulated throughout the institution. A 16 & 7 x 12-in. pump taking its suction from the large steel house tank provided fire protection. Two tank heaters with steam coils and one hot-water heater having a capacity of 1350 gal. per hour were used for hot-water service. All the pumps and equipment were in bad repair. The heaters on the heating system leaked so badly as to require constant renewal of the circulating water. The domestic-water heaters showed indications of heavy scale deposit. In the generating room one of the engines had a sprung shaft.

The general water supply was taken from the Des Plaines River, a reservoir being located approximately 2000 ft. from the power house. Adjoining this reservoir was installed a submerged centrifugal pump with vertical shaft, driven by a 75-hp. direct-current motor. The pump capacity was approximately 700 gal. per min. The discharge line of this pump was carried underground to a large steel tower of approximately 20,000 gal. capacity. From this tower connection was made to the water-softening plant and also to two domestic filters. From the latter lines were carried up to separate open surge tanks located in and supplying the various buildings with cold domestic water.

As the Des Plaines River is contaminated with sewage, the menace of this general water supply can be understood. Although the institution is served by drinking water taken from the deep well, there was no assurance against the help or children using the general water supply for drinking under certain occasions. In revamping the plant such an alternative was made impossible.

In equipping the new plant, it was necessary to keep the present equipment in operation without interrupting the service while changing over from the old to the new building. On account of the value of certain of the old equipment some of it was moved to the new plant after putting it in satisfactory operating condition, so that the selection and arrangement of the new apparatus had to be considered carefully to maintain satisfactory service.

The new power-house building, including boiler room, pump room, engine room, refrigerating room and general service rooms, was built to the north of the old plant. A tunnel about 150 ft. long extends from the pump room to the old boiler room. The tunnel is about 8 ft. wide and 9 ft. high, giving ample space for piping and permitting access from one building to the other. The boiler room had to be located conveniently to the spur track to permit delivery of coal in carload lots.

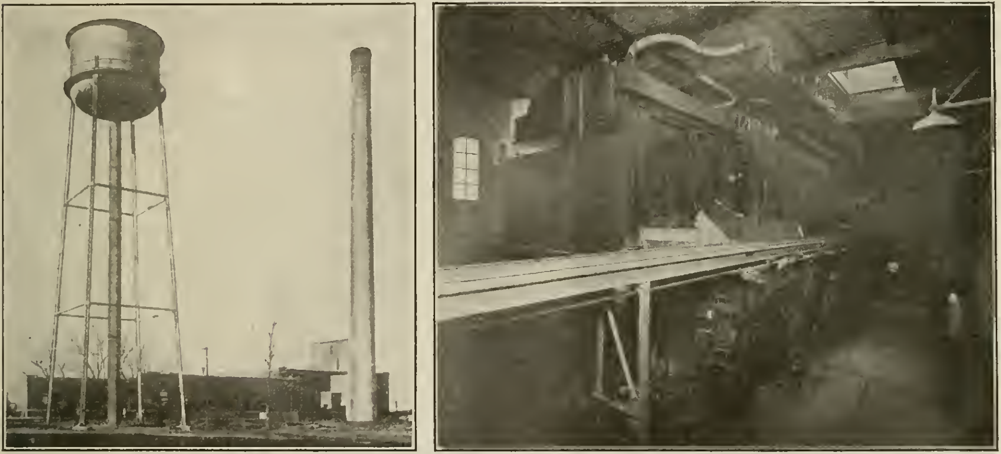
In the new boiler room the floor is approximately eight feet below grade. It is equipped with three 390-hp. Stirling boilers with space for one more, built for a working pressure of 160 lb. but operated at 110 lb. Top-feed stokers provided with extension furnaces serve the three boilers. The chimney is 8 ft. 6 in. in diameter by 175 ft. high.

Coal is delivered from bottom- or side-dump cars into a large storage bin below the tracks and at the front of the boilers. The bottom of this hopper is on a level with the boiler-room floor line and has doors into the boiler-room space, so that if the occasion warrants the coal may be transferred by hand to the stoker hoppers. Normally, the coal is conveyed through spouts from the under side of the track hopper to a scraper conveyor in the ash tunnel below the boiler-room floor. This conveyor carries the coal to a vertical bucket hoist that in turn dumps it into an overhead storage bin of approximately 50 tons capacity. This bin is directly above an industrial track resting on the top of the extension furnaces. From this point the coal is transferred to the stokers by means of an industrial car. As the tops of the furnaces are in line with the grade, a door is provided at the north end of the boiler room and an extension track carried out to an extensive coal-storage yard served by the spur track previously mentioned.

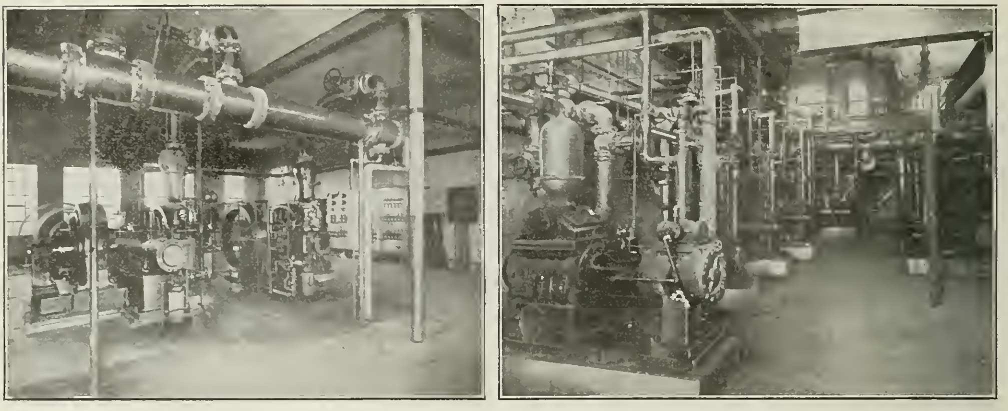
The ash spouts down to the same scraper conveyor that handles the coal and is elevated by the same vertical conveyor to a separate ash storage bin directly over the spur track, permitting discharge into the railway cars bringing in the coal. The conveying equipment has a capacity of approximately 25 tons per hour. The system is convenient, as it is possible to take the coal from the underground storage bin directly into the boiler room in case of accident to the conveyor, and the extension track permits coal to be transferred directly from storage to the stokers. In institutions of this kind isolated from general centers of distribution, ground storage of coal is essential to tide over delays in shipments, particularly during the winter period, when power requirements are heavy.

It was deemed advisable to use the old generating equipment, which had ample capacity to serve the institution. One engine was shut down, repaired and then moved over into the new plant. After this unit was in successful operation and the necessary temporary wiring connections to the old switchboard had been made, the second unit was revamped and moved over. Space was left in the engine room for the installation of one or more units to care for possible future growth.

The old switchboard was moved also, one panel at a time, and installed in the new engine room. On account of the expense of carrying the individual feeder lines through the tunnels to the switchboard in its new location, one main feeder line was run through the tunnel and connected to the branch lines in their original locations. At this point separate remote-control switches were installed for each feeder, control wires being carried back to the switchboard.



POWER PLANT AND PRESENT BOILER INSTALLATION OF ST. MARY'S TRAINING SCHOOL.



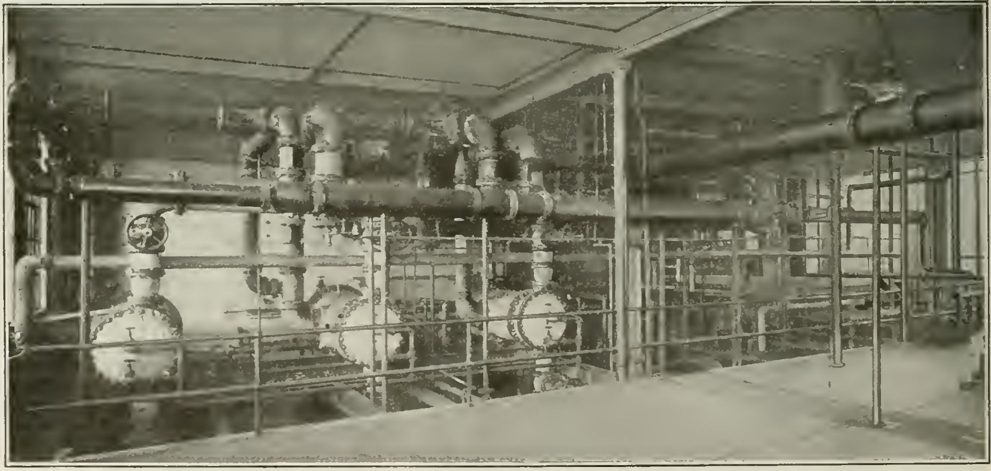
ENGINE-ROOM EQUIPMENT AND PUMPROOM AT BOILER-ROOM LEVEL

The pump room is on a level with the boiler room, eight feet below the engine room. There is no division wall, however, so that the pumps are under the observation of the operating force in the engine room. In this room are located the various pumps serving the installation, together with the old air compressor and the turbo-driven centrifugals for the hot-water heating system. The feed-water heater and the domestic hot-water heaters are on a platform about three feet higher than the engine-room floor. The piping tunnel connecting the two plants enters the pump room. The distributing piping and wiring are carried through this tunnel with the pipes either swung from the ceiling or suspended on the side walls.

The Refrigerating Service

In a room adjoining that provided for the generating equipment are the brine-circulating pump, condenser, ice-making tank and a large ice-storage refrigerator, the ammonia compressor being installed in the engine room. All the brine-circulating lines drop into the tunnel from the ice-making room and continue to the boxes in the main service building. An engineer's office, storeroom, toilet and locker rooms adjoin and are on the same level as the engine room.

On account of the condition of the old heaters on the heating systems and also taking into account the fact that the heating system would have to be kept in operation during construction, it was deemed advisable to install new hot-water heaters. The total heating load on the forced hot-water system is at present approximately 70,000 sq.ft. Three two-pass heaters were installed, each having 316 three-quarter-inch tubes 6 ft. long and being capable of heating 35,000 lb. of water per hour from a temperature of 160 deg. F. to 180 deg. F. when provided with steam at atmospheric pressure. The two turbine-driven centrifugal circulating pumps were put in condition and moved over to the new plant, one being maintained in operation in the old plant until the entire heating system was changed over to the new equipment. The second pump was then moved to its new location. Space was left for two additional heaters of the same capacity to provide for future extension.



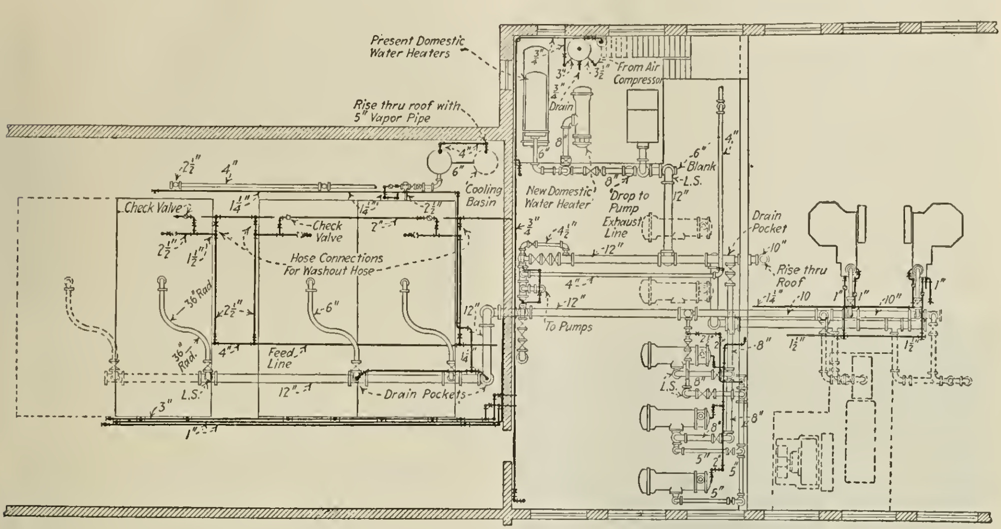
HEATERS FOR FEED WATER AND DOMESTIC SUPPLY LOCATED ABOVE PUMPROOM.

Two of the hot-water heaters are connected to the exhaust system, and one is connected to the auxiliary high-pressure steam system. The heaters are connected up in parallel, and the piping is so valved that any one or all can be operated on the system at one time. The water temperature is maintained by means of thermostatic control.

Two vacuum pumps are installed to handle the condensation from the hot-water heaters and also to care for the vacuum system previously mentioned. These pumps discharge into a standpipe that connects with the feed-water heater.

Revamping and changing of the water supply was one of the most interesting features of the work. The drinking water for the school was obtained from a 100-ft. driven well. The water is forced to the surface by compressed air and discharged into a large reservoir. From this reservoir the old drinking water pump forced the water through a pressure system to the various faucets throughout the building. The supply from this well was not adequate, and a new 1600-ft. well was sunk at a point adjoining the power house, with a concrete brick-lined reservoir built as a part of the system.

As previously mentioned, the contaminated river water had been used for general domestic purposes other than for drinking, the supply coming from the Des Plaines River. It was considered inadvisable to use this water when it was determined that the new well



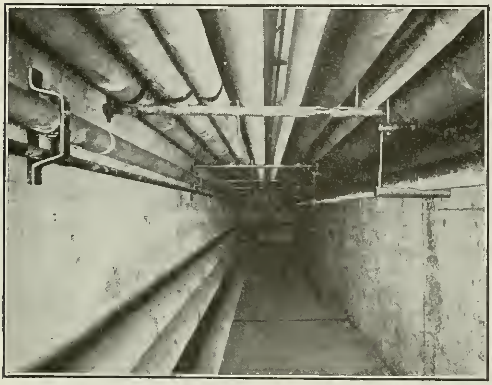
STEAM AND EXHAUST PIPING ST. MARY'S SCHOOL POWER PLANT.

PRINCIPAL EQUIPMENT OF ST. MARY'S POWER PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
3	Boilers	Stirling	390-hp	Generate steam	110-lb. steam, natural draft, stokers	Babcock & Wilcox Co.
3	Stokers	Top-feed	64 sq.ft	Serve boilers		American Foundry & Casting Co.
1	Chimney	Concrete	8 ft. 6 in. by 175 ft.	Natural draft for boilers		General Concrete Construction Co.
1	Conveyor	Scraper	25 tons per hr.	Coal from track hopper to bucket elevator	Motor-driven	Link-Belt Co.
1	Elevator	Bucket	25 tons per hr.	Coal to overhead bunker	Motor-driven	Link-Belt Co.
1	Industrial car	Side-dump	27-cu.ft	Coal to stoker hoppers		Link-Belt Co.
1	Pump	Simplex	14x9x12-in	Boiler-feed water	110-lb. steam	American Steam Pump Co.
1	Pump	Simplex	12x8½x12-in.	Boiler-feed water	110-lb. steam	American Steam Pump Co.
1	Pump	Simplex	10x6x12-in	Boiler washout	110 lb. steam	American Steam Pump Co.
1	Heater	Open	48,000 lb. per hr. from 150 to 210 deg. and 5,000 lb. per hr from 60 to 210 deg.	Feed water	Exhaust-steam	Warren Webster & Co.
3	Heaters	Closed	380-sq.ft	Hot-water heating system	Each 35,000 lb. water per hr. from 160 to 180 deg.	Alberger Heater Co.
2	Pumps	Centrifugal	1,500-g.p.m	Circulate hot water for heating.	Turbine-driven	De Laval Steam Turbine Co.
1	Softening plant	Cold-process	4,000-g. per hr.	Soften well water	Sludge filters	Pittsburgh Filter Co.
1	Heater	Instantaneous	6,000-g.p.h. from 60 to 180 deg.	Domestic hot water		Alberger Heater Co.
2	Heaters	One U-tube, one storage-type	2500-g. per hr., 1,000-g. per hr.	Domestic hot water		Berryman
1	Pump	Simplex	14x10x12-in.	Treated water pump	110-lb. steam	American Steam Pump Co.
2	Pumps	Simplex	10x8x12-in	Drinking water	110-lb. steam	American Steam Pump Co.
1	Pump	Centrifugal	2-in.	Domestic hot water	Motor-driven	American Steam Pump Co.
2	Pumps	Vacuum	10x12x12-in.	Vacuum-heating system	110-lb. steam	American Steam Pump Co.
1	Pump	Underwriters	16x9x12-in.	Fire and general service	110-lb. steam	Worthington Pump & Mach. Corp.
1	Air compressor	Straight-line	386 cu.ft. at 250 r.p.m	Air-lift	110-lb. steam, 45-lb. air	Ingersoll-Rand Co.
1	Air compressor	Straight-line	150 cu.ft.	Air-lift	110-lb. steam, 45-lb. air	Chicago Pneumatic Tool Co.
2	Engines	Simplex high speed	13x12-in.	Generating units	Noncondensing, 250 r.p.m., 110 lb. steam	Ames Iron Works
2	Generators	Direct-current	75-kw	Generating units	125-volt, direct-connected	Sprague Electric Works
1	Compressor	Ammonia	8$\frac{1}{16}$x12$\frac{5}{8}$ in., 12-ton ice-making cap.	Refrigerating plant	Motor-driven	Fred W. Wolfe
1	Condenser	Double-pipe	20 pipes, 20 ft. long	Refrigerating plant		Kroeschell Bros. Ice Machine Co.
1	Combination brine and ice tank		20 ft. long, 10 ft. wide, 3 ft. high	Brine cooling and ice making		Kroeschell Bros. Ice Machine Co.
1	Pump	Simplex	8x7¼x12-in	Brine circulating	110-lb. steam	American Steam Pump Co.

would give a flow of approximately 350 gal. per min., which, coupled with the flow from the old 100-ft. well, was sufficient for the entire needs of the institution.

Abandoning the old system proved to be a happy solution, as it eliminated the load due to the 75-hp. motor at the river and eased off considerably on the service required of the relatively small generating equipment. It also did away with the trouble experienced with the 112-volt direct-current transmission line to the motor. The river pumping plant was shut down and the new deep well made ready for service. An underwriters' fire pump having a capacity of 750 gal. per min. transferred the water from the reservoir of the deep-well system into the steel tower. From this point the water went to the softening plant, supplying also all of the domestic cold water. The fire pump was connected to the fire line and cross-connected on its suction with the old river-water system, so that if the deep well failed to give sufficient water for fire protection the fire pump could be thrown automatically on the river supply, though normally operating on the deep well.


METHODS OF SUPPORTING PIPE IN TUNNEL

Being absolutely clear, the deep-well water obviated the necessity of the two domestic-water filters that had to be used when the supply was taken from the river. These filters were installed in conjunction with the softening plant to provide the needed increase in filtering capacity. The water treatment had to be changed to some extent, as the deep-well water ran about 22 grains per gallon as compared to 16 grains for the river water. The operation of the system, however, was more satisfactory, as the deep-well water was of constant hardness while the river water was continually changing owing to dilution after heavy rains.

It was necessary to operate the drinking-water pumps and in addition install two more pumps to provide a reserve for this service. These pumps can take their suction from either as conditions require. A new compressor having a capacity of 386 cu.ft. per min. at 250 r.p.m. was installed as a relay to the old compressor.

For the boilers a new feed pump was installed to operate in conjunction with the two older pumps, one of the latter being connected up for boiler washout purposes. An additional domestic hot-water heater of the instantaneous type having a capacity to heat 6000 gal. of water per hour from 60 deg. to 180 deg. with steam at atmospheric pressure was provided. The heater contains 128 three-quarter-inch tubes 6 ft. long arranged for four passes. The installation also included a special feed-water heater of the open receiver type, capable of heating 48,000 lb. of water per hour from 150 deg. to 210 deg. and 5000 lb. of water per hour from 60 deg. to 210 deg. This combination heater was called for, as much of the water was condensation returned from the hot-water heaters at a temperature approximating 150 deg. The 5000 lb. of water raised from 60 deg. to 210 deg. was the approximate estimate of the makeup water required for the system.

Many unforeseen difficulties arose during construction, particularly in changing over from one plant to the other. This work, however, was accomplished without interruption of the service. The refrigerating plant was moved during the winter and placed in operation in sufficient time to renew the service in the spring. Sufficient space has been left to permit doubling the boiler capacity at any future time. The equipment is well protected by relays, and the size is such as to permit carrying double the present loads. The new power plant is well adapted to the uses of this particular institution. The engineering work, including the building, was designed by Neiler, Rich & Co., of Chicago, who had entire charge of all the work involved in the project.

Water-Power Development in Europe

It is said that the water power of Bavaria is capable of generating 809,100,000 kw.-hr. annually. It is proposed to utilize this power and augment it by means of steam installations to the extent of 162,900,000 kw.-hr., combining the supplies in one network. The estimates for the scheme give the capital cost as £14,195,000 ($69,072,870) and an annual expenditure of £1,682,500 ($8,181,045.)

In a paper on "Water Power Development," read before the Royal Society of Arts, Prof. A. H. Gibson recently remarked that when it is realized that the total industrial requirements of the world at present, excluding shipping, amount only to about 95,000,000 hp., involving, however, under present conditions, the consumption of some 600,000,000 tons of coal per annum, and, moreover, that this is not continuous power, but is in general utilized only for some 3000 hours per annum, it is evident the water power of the Empire, if efficiently utilized, would be sufficient in amount to perform the major portion of the world's industrial work, and that this water power is bound to be a powerful factor in determining the economic destiny of the Empire.

Among the various European countries that have lately been giving special attention to the development of water power, France is one of the most progressive. In that country approximately 850,000 hp. has been put into operation or into development since 1915. In Italy concessions involving about 300,000 hp. are already under way or are being considered. In Iceland one scheme involving the development of over 1,000,000 hp. is in contemplation. In Spain various large projects, including one estimated to give 350,000 hp., are under consideration. In Japan many projects are in course of development. In Austria and Russia, in spite of the disturbed conditions, considerable attention is, according to all reports, being paid to hydro-electric developments, particularly in the former country, with reference to the electrification of railways.—*The Engineer*, London.

Single-Phase Load on a Two-Phase System

By J. B. Gibbs
Engineer Transformer Department The Westinghouse Electric & Manufacturing Company

The best way to connect a single-phase load to a two-phase generator is to divide the load into two equal parts and connect one of the parts to each phase of the generator, as shown in Fig. 1. This gives a balanced load on the generator and the best possible conditions in the line and transformers. For this connection two transformers are needed having a combined rating equal to the load.

If the single-phase load cannot be divided, and if it is small in comparison with the power system, it is usually best to connect it to one phase of the two-phase system and not try to balance the two phases. Such a load requires one transformer having a rating equal to the load. Large power systems usually have numerous small single-phase loads which are scattered so that the phases are approximately balanced.

If the load is large in comparison with the generator, an advantage may be gained by connecting as shown in Fig. 2. Two transformers are needed. The primary of the first is connected to one phase of the generator and the primary of the second to the other phase. The two secondaries are then connected in series. The single-phase voltage delivered to the load may be found as follows:

The voltage of the first transformer is 90 deg. out of phase with the voltage of the second. This means that at the instant when the alternating voltage on the first transformer is passing through its maximum value, the voltage on the second is passing through its zero value. These two voltages may be represented by vectors, as in Fig. 3. OE_1 is drawn of a length proportional to the voltage delivered by the first transformer, and OE_2 is drawn at right angles to OE_1 and of a length proportional to the voltage of the second transformer. If two similar transformers are used, the lengths of OE_1 and OE_2 will be the same, since the two secondary voltages are equal. Both these voltages act on the load, and therefore the single-phase voltage will be the resultant of the two. Complete the square as shown by the dotted lines and draw the diagonal OD. This will represent the single-phase voltage. If OE_1 and OE_2 be taken as 100 per cent. the resultant will be the hypotenuse of a right triangle and will be equal to

$$OD = \sqrt{(100 \text{ per cent.})^2 + (100 \text{ per cent.})^2} = 141.4 \text{ per cent.}$$

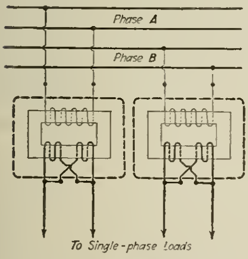


FIG. 1. TWO SINGLE-PHASE LOADS ON A TWO-PHASE SYSTEM

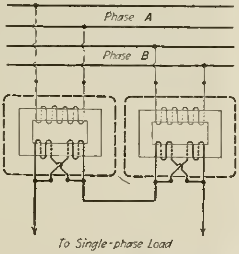


FIG. 2. ONE SINGLE-PHASE LOAD ON A TWO-PHASE SYSTEM

For example, if the secondary voltage of each transformer is 110 volts, the resultant single-phase voltage will be 110 × 1.414 = 155.5 volts.

If the same two transformers were similarly connected to a single-phase line, they would deliver the same current at a voltage of 110 + 110 = 220 volts. The connection to the two-phase line, therefore, takes transformers having a rating $\frac{220}{155.5} = 1.414$ times as large as the load. Usually, the resultant single-phase voltage will have to be changed to one of the standard voltages, such as, 110 volts, 220 volts, etc., by means of another single-phase transformer or an auto-transformer.

The effect of a single-phase load connected in this way to a two-phase generator is to set up an armature reaction which will raise the voltage on one phase of the generator and lower it on the other. In extreme cases, where the single-phase load is large compared with the generator rating, this unbalance may amount to from 10 per cent. to 20 per cent.

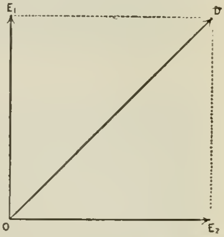


FIG. 3. VECTOR DIAGRAM OF TWO-PHASE VOLTAGES

It has been pointed out by B. G. Lamme that one single-phase load can never give a balanced condition in a polyphase system, for the reason that single-phase power is pulsating while polyphase power is continuous. To get a balanced load, therefore, it is necessary to have something with a flywheel effect to take up the pulsations.

Summing up the foregoing, it is seen that a single-phase load can be connected to a two-phase power system in several ways:

1. It may be divided into two equal parts and connected separately to the two phases. This requires two transformers with a combined rating equal to the load and is the best method.
2. A small single phase load may be connected to one phase of the system, using one transformer whose rating is equal to the load.
3. It is sometimes advantageous to connect a large single-phase load across both phases of the two-phase system. This requires two transformers having a total rating equal to 1.414 times the load. In addition these transformers must have a special voltage ratio, or else an additional single-phase transformer or auto-transformer must be used.
4. No one single-phase load can produce a balanced condition in a polyphase generator.

The proposed bridge across the Mississippi River at Minneapolis will have the longest reinforced-concrete arch in the world. The present longest is the Risorgimento Bridge at Rome, 328 ft. long. The Minneapolis bridge will have a center span of 400 ft., two side spans of 200 ft., and two end spans of 60 ft.

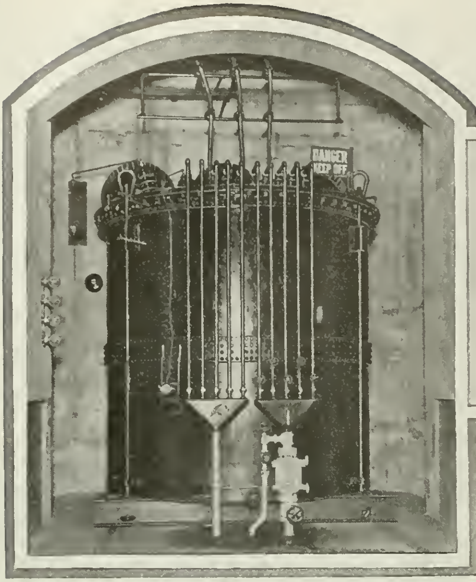
Operation at Holtwood

CARING FOR THE MAIN TRANSFORMERS

By

Charles H. Bromley

How the transformers are cleaned and inspected. Cleaning the cooling coils. Testing, Sampling the transformer oil.



TYPICAL FRONT VIEW OF HOLTWOOD TRANSFORMER

In addition to the usual fittings and attachments furnished by the manufacturer, note the submerged-bulb-type oil thermometer with round dial mounted at man's height to the left; thermometers in ingoing and outcoming water manifold; the danger sign on top of transformer, mounted on a swivel in locked position; red and green automatic signal lamps indicating closed and open positions of low- and high-tension switches, located on the left of the compartment.

The transformers (see the headpiece) are practically under continuous surveillance. The operators are always watching the load distribution on the various transformers, watching the temperatures and water flow, and are keen to any change in the musical hum of the transformers which would indicate an abnormal operating condition. Readings of transformer load, oil temperature and incoming and outgoing water temperatures are taken every hour and recorded. If there is an abnormal difference in the temperature between the incoming and outgoing water when the flow of water is normal and the transformer is not overloaded, it means that the cooling coils are clogged and must be cleaned as described below.

The entrance bushings and transformer tops are cleaned and inspected weekly. At this time the loads, both high- and low-tension, and the insulators are cleaned and felt to ascertain if the insulating supports are rigid or loose. The reactances are cleaned and inspected monthly. Loose bolts and shrinkage of wooden filler pieces are looked for.

The neutral ground stacks (see Fig. 2) are cleaned and inspected every three months, at the time of the high-tension bus inspection. The stacks are carefully watched for broken grids and loose connections. Other than the regular inspection, the stacks are examined after each time that ground current has passed through them. Satisfactory operation of the arc extinguisher, interlocking relay and field relay depend upon these stacks. An open-circuit or other fault, besides crippling the relay protecting system, may cause violent arcing, possibly on the high-tension bus itself. In the event of ground current on the high-tension side not being promptly cleared by the relays, the transformer grids may become red-hot and sag sufficiently to short-circuit one another during a subsequent ground.

Cooling Coils—Once a month the cooling coils are blown out with air at 100 lb. pressure to remove sediment. One coil at a time is blown out. This is done by closing the main water-supply valves and valves to the individual coils, admitting air pressure to the manifold; the air blows out the coil that is open. Each coil is blown out three times at least, but before blowing each time it is first filled with water.

The insulation resistances of the high-tension winding to ground, low-tension winding to ground and high-tension winding to low-tension winding are measured annually. Each year there is made a high-potential test of 15,000 volts on the low-tension side for one minute.

Sampling and Testing Transformer Oil—A sample of oil is drawn from each transformer every month. Glass bottles for the purpose are provided. Each transformer has its own bottles, the use of which for other transformers is forbidden. The first quart or two of oil drawn from the bottom of the transformer is used for rinsing the bottle and then discarded. The bottle is then filled to overflowing, and is sealed and tagged.

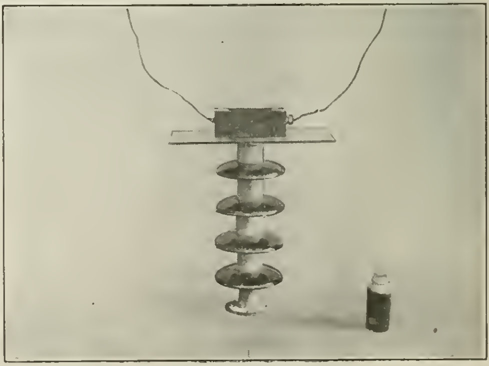


FIG. 1. TESTING TRANSFORMER OIL

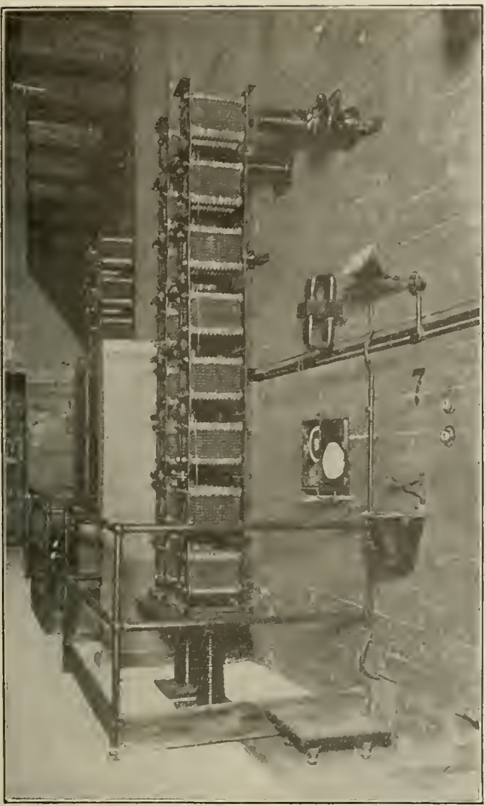


FIG. 2. NEUTRAL GROUND STACK CONNECTED IN STAR POINT OF HIGH-TENSION WINDINGS
Instrument to the right records ground current

Samples are tested in the testing transformer at Holtwood. The testing box (see Fig. 1) is cleaned, rinsed out with a small part of the oil sample, and the electrode terminals adjusted to 0.2 in. apart. The electrodes also are washed by oil taken from the sample. The box is now filled to within one-eighth inch of the top, and all air bubbles are broken with a glass rod. The voltage is applied and increased slowly and steadily at the rate of 50,000 volts in thirty seconds. The voltage at which the first spark across the gap occurs is recorded, also the voltage at the final breakdown. Three consecutive tests are made on each sample and the average recorded.

Good transformer oil should have a breakdown strength of 40,000 volts for a 0.2 in. gap. At Holtwood, oil that tests less than 30,000 is replaced at once. If retest shows breakdown between 25,000 and 30,000 volts, the oil is refiltered at the earliest convenience; if test shows less than 25,000 volts, the oil is filtered at once. When the oil tests between 30,000 and 40,000 volts, it is watched closely at the next monthly test to see whether the tendency is up or down. If on the next test it shows 40,000 volts, it is refiltered. The oil in use at Holtwood tests 50,000 to 60,000 volts. All filtered oil, new or old, is expected to test at least 40,000 volts immediately after filtering. If avoidable, oil is not tested damp days.

The transformer temperatures are not permitted to rise above 60 deg. C. (140 deg. F.) and in winter weather are not allowed to fall below 2 deg. C. above room temperature. Regulation of temperature is had by cutting in or out cooling coils. In the winter, changing over from forebay water to "hill" water keeps the transformers from becoming too cold. In severe cold weather it may be necessary to cut out all cooling coils and to excite idle transformers for a few hours every day. Caution is taken that the cooling-water main, which runs along the stop-log gallery, does not freeze when the transformer is idle and little water is passing.

Nos. 1 and 2 transformers, which are on the northern end of the power house and have external oil-filled cooling coils submerged in a water tank, have their temperature regulated best by adjusting the flow of water in the cooling tanks in the stop-log gallery. When shutting off from the cooling-tank water is not sufficient, the oil-pump motors are shut down, but care is taken to see that under no circumstances are the throttle valves on the oil lines closed, as such a condition would prevent natural circulation of the oil and likely cause local heating in the transformer.

All transformers which have their water or forced oil circulation shut off are carefully watched to detect sudden temperature rises. See screens, Fig. 3.

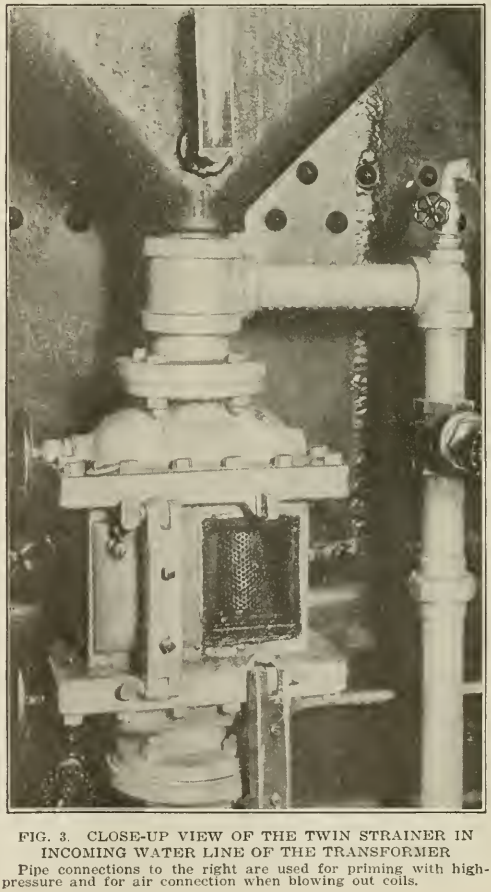


FIG. 3. CLOSE-UP VIEW OF THE TWIN STRAINER IN INCOMING WATER LINE OF THE TRANSFORMER
Pipe connections to the right are used for priming with high-pressure and for air connection when blowing out coils.

Functions of the Ammonia Condenser

By H. J. MACINTIRE

IN THE direct system of refrigeration there are three parts to the cycle—the compressor, the condenser and the so-called expansion coils. Of these three the condenser is the simplest and perhaps the least understood. The condenser is only a device to abstract heat from the ammonia (much simpler than the apparatus used for steam condensation) by the use of cooling water. The compressor superheat is first removed, then the latent heat of liquefaction, and then some heat is removed to reduce the temperature of the liquid ammonia. The object of the following is to bring forward the theory of the condenser in a simple manner, to show what the condenser must do, and finally to explain why inherently some designs of condensers must be inferior to others.

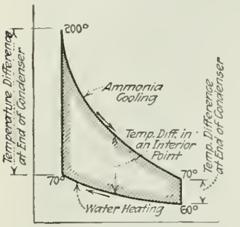


FIG. 1. DIAGRAM OF COOLING EFFECT WITH COUNTER-CURRENT CONDENSER

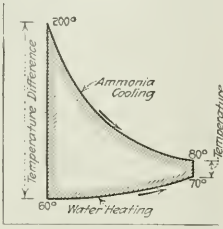


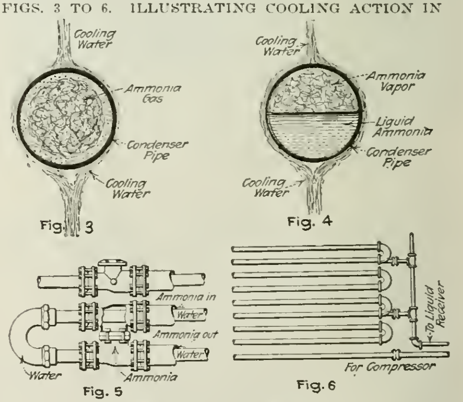
FIG. 2. COOLING EFFECT WITH OLD ATMOSPHERIC-TYPE CONDENSER

Now it must be remembered that the discharge gas from the compressor has a temperature between 140 and 240 deg. F. approximately, and that the heat in this gas above the temperature of about 80 deg. F. is called compressor superheat. The gas when superheated is dry and behaves differently from saturated ammonia, which may have more or less liquid ammonia always present in the form of a mist. The action of the condensers is first to remove the superheat and then to remove the latent heat of liquefaction; and while this heat is removed, the condensing water is heated five, ten or more degrees in temperature, depending on the relative amount of water being used for cooling. This action can be shown diagrammatically in Fig. 1, where the upper line shows the action of cooling the ammonia from 200 to 70 deg. and the lower line shows the action of heating the water from 60 to 70 deg. F. and the arrows show the relative direction of flow of the liquids, which is counter-current, or opposite in direction, in this case. The heat removed by the water is equal to the refrigerating duty performed plus the heat equivalent of the work of compression done by the compressor.

In another form of condenser the ammonia and the water flow in the same direction, as in the case of the old atmospheric type shown diagrammatically by Fig. 2. Here the coldest water comes in metal contact with the hottest ammonia and the condensed ammonia comes in metal contact with the hottest water. Now it must be remembered that in heat-transfer apparatus, such as condensers, it is necessary to have a temperature difference between the two substances and that heat will not run uphill, but only from the hotter to the colder substance. In consequence it will be noticed in Fig. 2 that the liquid ammonia is cooled only to 80 deg., whereas in Fig. 1 it was 70 deg., thereby giving in each case a final temperature difference of 10 deg. between the two surfaces of the condenser.

The object of the condenser is to remove heat from the compressed gas and to return the ammonia to a condition of a liquid that it may be fed again to the expansion coils. This means that: First, a cooling medium (water) must be provided; second, a temperature difference must be obtained; third, sufficient cooling surface must be available. Furthermore, the surfaces must be efficient and not insulated by foul gases or air or choked up by condensed liquid ammonia. In other words, a certain number of heat units must be removed by the cooling water every minute. In order to do so it must have a temperature difference (temperature head similar to a waterfall with water or potential in the case of electricity) and the proper amount of *efficient* cooling surface. The method of obtaining efficiency of the surface of the condenser is the reason for many and varied kinds of condensers.

FIGS. 3 TO 6. ILLUSTRATING COOLING ACTION IN



AMMONIA CONDENSERS

Figs. 3 and 4—Liquid, gas and water in and on condenser coils. Fig. 5—The double-pipe condenser. Fig. 6—The bleeder-type condenser.

In calculating condenser surface we use the external surface of the pipe, assuming that every square inch (top as well as bottom) is equally efficient. The metal is used only as a container for the ammonia. Heat is transmitted from the vapor or superheated ammonia to the metal, then through the metal to the water and is carried away by the water. Now suppose some air or inert gas collects on the inner walls of the condenser. This may easily occur, and does occur in every condenser. Then this foreign gas forms a film or skin on the metal and insulates the metal, Fig. 3. The reader will remember that air films make the most perfect insulator known. The effect of this is to decrease the rate at which heat will be transmitted through the condenser. By this is meant the number of heat units which can be conducted through the metal walls for every square foot with a temperature difference of one degree, during a time of one hour, as it is usually expressed. The value for this so-called coefficient of heat transmission may be 200, but if a gas film is present on the pipe surface it may be reduced to 50 or less.

As was mentioned, the vapor film is always present on both sides of the pipe. Its baneful action may be diminished by scouring it away by making the substances on the two sides of the pipe move vigorously. A vigorous current of ammonia vapor along the pipe has the same action as water running down a mountain brook—it scours the sides and removes this gas film. Therefore it is evident that if the condenser is operated so as to increase the velocity of the vapor in the condenser, the efficiency of the condenser will increase and more work can be obtained from it. However, to get this velocity of the vapor work must be done on the vapor by the compressor so that the advantage is not all clear gain.

Again, some designs of condensers allow the pipes to fill part way with liquid ammonia. This is particularly true of the old atmospheric and the so-called flooded condenser. Referring to Fig. 4, it will be seen that the lower half is filled with liquid ammonia. That the accumulation of a liquid, as in this case, practically nullifies the action of that part of the condenser can be seen by anyone who has studied the action of the steam boiler. In this case the useful part of the condenser is reduced in proportion to the amount of submerged surface. Of course some heat is transmitted through the liquid, but the action is very sluggish as compared with the other portion of the pipe.

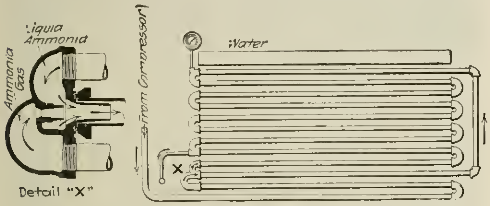


FIG. 7. SHOWING THE FLOODED CONDENSER

What then are the requirements of a condenser to get best heat transfer? It must be free from air or foreign gases and it should have a velocity flow of the vapor which will tend to clean the metal surface. It must be free of oil or scale on both the inside and outside surfaces. It must be arranged so that the liquid when precipitated will be readily and quickly drained off. And finally, as economy of the refrigerating plant—as regards both head pressure and refrigerating effect of the condensed ammonia—is dependent on having as low a temperature of the liquid ammonia as is possible, the condenser should be designed on the counter-current principle.

Now, what condensers are best suited for all these requirements? If good condensing water were available, the double-pipe condenser (counter-current) would answer every requirement. Foreign gases are removed by purging. The scouring action is obtained by the construction (Fig. 5). The only objection is that the lower pipes are likely to be partly filled with liquid ammonia, but this is partly compensated by the fact that the liquid is cooled as near the temperature of the incoming condensing water as is practical. The design, however, is costly, there are a number of joints to keep tight, and water tending to accumulate sediment cannot be used.

One of the oldest designs, and one that answers the requirements of an efficient condenser, is the so-called bleeder type of atmospheric condenser. This is counter-current (Fig. 6), the superheated gas entering at the bottom, and as it works its way upward and is condensed, it is drained off to the receiver. If properly constructed, there should be little or no accumulation of liquid, and the design is such as to be very inexpensive to make. The flow is toward the upper header, where the inert gases are readily purged. As the cooling water is always on the outside, the scale or sediment may be cleaned readily. The only real objection is that the liquid ammonia is not precooled, but is drained off as it is condensed.

Finally (Fig. 7), as regards the flooded condenser: The real object of such a condenser (which attempts to use condensed liquid ammonia to remove the compressed superheat by a kind of jet condenser action) is to try to overcome the poor heat transference from dry, superheated ammonia to the cooling water. If the ejector effect is automatically controlled to suit the load, the condenser will operate all right, although the condition shown in Fig. 4 will always be present. Experience has shown that when adjusted to the conditions then prevailing, the flooded condenser will work very well, but that any change may make the head pressure increase greatly. Tests have been published attempting to show that no advantage was derived by the flooded condenser, and of two evils most engineers prefer a low operating cost to a low first cost. The writer's personal opinion is that there is no advantage in the flooded condenser which the bleeder type cannot equal, also that the latter is the best all-around condenser made at the present time.

Large Single-Shaft Turbine in Berlin

By Dr. F. E. Junge

The General Electric Co., of Berlin, has just completed a turbo-generator set of 50,000 kw., or 67,000 hp. in a single unit. This, the largest machine of its kind in Europe, and like some other large installations is a single shaft unit generating its current in one generator.

The generator rotor weighs 106 tons; the weight of the complete generator is 225 tons. The turbine rotor weighs 49 tons and the complete steam turbine, 250 tons. To transport the various parts of the unit to the place of destination quite a number of special cars had to be constructed, among them one with five axles for the rotor part of the generator.

The power plant comprises two condensers, each having a cooling surface of 3000 sq.m. (32,292 sq.ft.) which is subdivided into four parts so as to facilitate transportation. The weight of the condensing plant is 100 tons. The steam turbine contains 10 blade wheels, the diameters of which vary from 3.4 to 3.8 meters (11.15 to 11.46 ft.), the circumferential speed of the wheels varying accordingly between 180 and 220 m. per sec. (590.4 and 72-16 ft. per sec.).

Owing to the absence of nickel and other high-class materials, guides and blades had to be specially designed, being cut from solid blocks of metal, of the material of which the finished blade represents only 15 per cent. The generator rotor has an external diameter of 2.2 m. (7.22 ft.) and a circumferential speed of 115 m. (377.2 ft.) per sec. Its total length including shaft stubs being considerable, it had to be composed of a series of disks, mounted and compressed on a common shaft.

The generator rotor was tested at a speed 50 per cent. beyond the normal; namely, at 1500 r.p.m. The single sectors or disks were subjected to even more severe tests at 2000 and 2400 r.p.m. The three main bearings of the set have a diameter of 0.6 m. (1.968 ft.) a circumferential speed of 32 m. (105 ft.) per sec. Owing to the colossal load which it supports, the middle bearing is divided into two parts. The rigid coupling between turbine and generator rotor is contained between.

This central bearing is rigidly connected with and supported by the main frame, while the turbine housing and its steam connections rest on the middle and front bearings respectively and can glide along the main axis, thus yielding to the expansion and contraction produced by varying temperatures. The main frame rests on a broad foundation of concrete steel.

The Coking-Coal Chain Grate

A successful coking chain-grate stoker suitable for burning and caking coal must be provided with some sort of an oscillating coking plate to break up the fuel bed during the early stages of combustion, in addition to the usual chain-grate surface. Such a stoker is manufactured by the Green Engineering Co., East Chicago, Ind. From the general view, Fig. 1, it will be seen that the stoker is provided with a horizontal deadplate over which coal is pushed into the furnace, an inclined adjustable deadplate directly below this and an oscillating plate below the adjustable coking dead-plate.

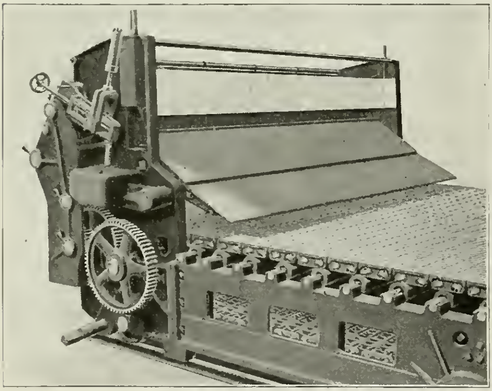


FIG. 1. CHAIN GRATE STOKER FOR COKING COALS

Fuel is pushed from the stoker hopper under the gate by means of a pusher resting on the horizontal deadplate. The pusher receives its motion from an eccentric through a walking-beam and rocker-arm mechanism. A through shaft communicates this motion uniformly to both sides of the stoker, thus actuating the pusher from both ends. The design of the pusher provides flexibility in firing as the end adjustments allow quick increases in the rate of firing and permit feeding more or less coal on either side of the grate as desired. The pusher is divided into sections 12 in. wide, each of which is provided with a variable stroke mechanism so that the amount of fuel fed to any section of the grate is under control independent of the rest of the grate surface. This makes it possible to regulate the feed so as to prevent uneven fuel-bed conditions.

As the coal is pushed over the horizontal dead-plate, it passes onto an inclined adjustable dead-plate the width of the stoker and 14 in. deep. This plate is made up of a series of sections 18 and 24 in. wide, mounted on a square shaft in such a manner that the slope can be adjusted to suit coals of varying coking tendencies, but no operating motion is given.

From the adjustable dead-plate the semi-coked fuel passes to the coking plate forming the lower stage of the incline before reaching the chain surface. The coking plate is the width of the furnace and 18 in. deep. It is divided into sections 18 and 24 in. wide, mounted on a square shaft, to which an oscillating motion is given by means of an eccentric and walking beam. The lower edge of the coking plate moves through an arc of variable degree as to amplitude and location, governed by the position of an adjusting screw.

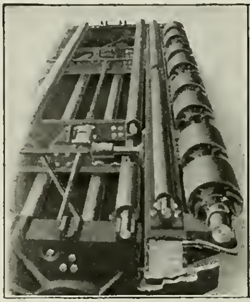


FIG. 2. WATER-COOLED REAR GIRDER

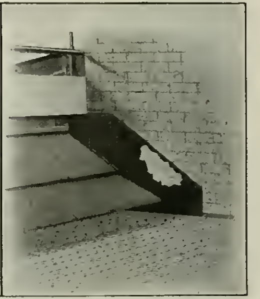


FIG. 3. WATER-COOLED LEDGE PLATE

The motion of the fuel pusher and coking plate is independent of that of the stoker chain so that it is possible to feed fuel beds of any practical depth onto either a slow or fast moving chain and to provide any desired amount of agitation to the coking plate necessary to maintain a porous fragmentary fuel bed at the chain surface.

One important function of the incline is that the fuel bed is tipped at an angle to expose the green fuel to direct radiation from the rear portion of the fuel bed. On this account fuel is ignited at a rate beyond the possibilities of igniting arches on plain chain grates, so that the stoker is responsive to sudden increases in steam demand.

A semi-steel box of large section arranged for water circulation is shown in Fig. 2. Provision is also made to keep the incandescent fuel from coming in contact with the brickwork in the setting walls adjacent to the to the coking plates, as in a heavily agitated fuel bed accretions are formed during the distillation of the tars. The water-cooled ledge plates shown in Fig. 3 serve to prevent clinker adhesion and erosion of the brickwork.

Work has begun on the $2,500,000 hydro-electric power plant of the San Joaquin Light and Power Co., on the San Joaquin River. The plant when completed will develop 28,000 hp. The tunnel feeding the water turbines will be about two miles long.

Riley Two-Speed Gear Box

The tendency in stoker operation is toward greater flexibility of operation so that the feed of the coal may be retarded or accelerated as desired and the fire can be leveled, thinned or thickened as required. These results are obtained in the instance of the Riley stoker by means of the new two-speed gear box. It differs from the regular design of stoker gear box in that it contains in addition to the worm gearing, a double set of spur gears so arranged that by shifting a lever from the high to the low position or vice versa the coal feed is increased or decreased.

When a number of stokers or gear boxes are driven by a single prime mover, any stoker or the retorts on any gear box can be operated practically independently of all other stokers or gear boxes. This effects a saving in fuel since there is no necessity for carrying over coke when trying to divide the load equally among a number of stokers, or when building up thin sections of the fuel bed in a wide furnace.

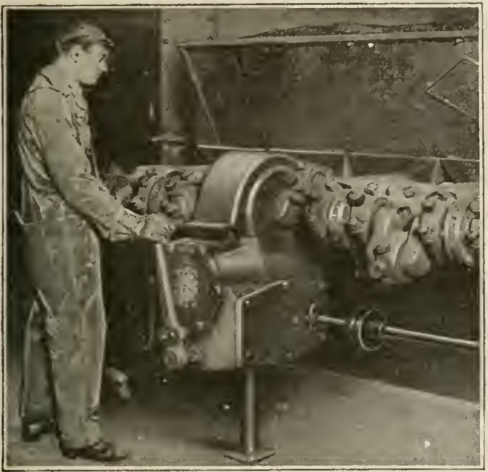


FIG. 1. TWO-SPEED GEAR BOX APPLIED TO A 14-RETORT STOKER

With the stokers driven by an ordinary engine or motor, double the usual range of speed is obtained. This is an advantage at high ratings (300 to 350 per cent.). The stoker countershaft at these loads usually has a speed of from 400 to 450 r.p.m. Suppose, for example, the load is suddenly reduced to about the rating on the boilers. An engine, to handle this, would need to operate from 100 to 150 r.p.m. Such low speeds are not only likely to stall the engine, but are extremely wasteful of steam by shifting the two-speed gear-box lever from high to low speed, the engine can run at from 200 to 300 r.p.m. an efficient speed for economical operation.

The installation of the two-speed gear box, manufactured by the Sanford Riley Stoker Co., Worcester, Mass., makes the slip-ring induction motor more suitable for stoker drive. A 2 to 1 reduction in speed is all that can be obtained electrically, but with this new device an over-all range of speed of 4 to 1 is obtained. A multi-speed motor with four speeds (600, 900, 1200, and 1800 r.p.m.) can now give the equivalent of 300, 450, 600, 900, 1200, and 1800 r.p.m. If the motor operates at a maximum of 1800 r.p.m. during peaks, then a sudden change in steam requirements does not necessitate feeding an excess amount of coal to the boiler. A single throw of the shifter lever from left to right, cuts the coal supply in half. This is done without a change in the speed of the motor.

Figs. 1, 2 and 3 show the simplicity of an installation. Fig. 3 shows how all gear boxes are driven from one through shaft. It is therefore obvious that all sprockets and chain connections, chain guards, countershafts, and bearings usually required for each gear box are eliminated, and each stoker so equipped has but one chain connection. With large units this saves a great deal of mechanism underneath the stoker. By using the two-speed gear box the stokers could be set much lower; in fact, the bottom of the box can be set on the floor, which enables the stoker to be set low and gives maximum combustion space for the gases.

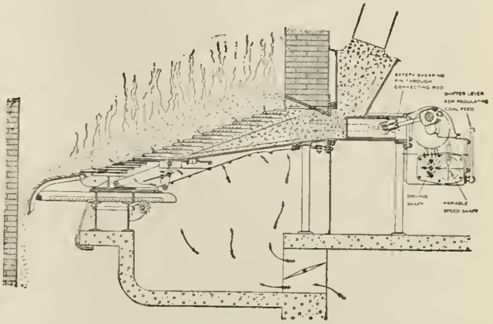

SAFETY SHEARING PIN THROUGH CONNECTING ROD
SHIFTER LEVER FOR REGULATING COAL FEED
DRIVING SHAFT
VARIABLE SPEED SHAFT

FIG. 2. SIDE ELEVATION OF GEAR BOX, SHOWING ARRANGEMENT OF GEARS

The use of this additional regulating feature does not interfere with the continued use of any automatic regulating device; in fact, it allows a more intelligent use of any automatic regulator on the stoker drive, and it is so constructed that it may be applied to any type of Riley stoker.

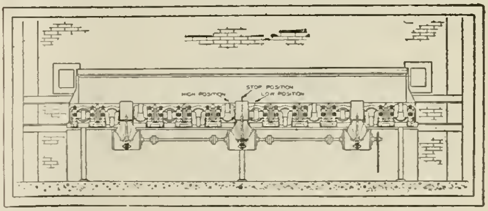


FIG. 3. SHOWING CONTINUOUS SHAFT LINE

The old adage has it that "time is money," and yet some of the poorest people we know have all the time there is on their hands. Time is money only when we turn it into money; that is, when we make ourselves so efficient, so capable or of such service to others that our days and hours can readily be exchanged for cash. Time is money only when we can, by the strong transforming power of real ability, produce something, somewhere, which is in demand by somebody.

The frames of all motors, switchboxes, transformers, etc., should be substantially grounded.

Some Facts About Monel Metal

BY HUGH R. WILLIAMS*

CONDITIONS surrounding the use of high-pressure steam, particularly when superheated, are different from those met with in low- or medium-pressure saturated steam practice. High-pressure strains, greatly elevated temperatures and intensified erosive action, all have to be contended with, making necessary the employment of much equipment of a character different from that suitable for less severe conditions. Particularly is this so of the metals employed.

The requisites for a metal to withstand the high pressures, the total heat—possibly as high as 800 deg. F., or even higher—and the erosive action of high-pressure superheated steam are: (1) High tensile strength at all temperatures; (2) low heat conductivity; (3) high modulus of elasticity; (4) a coefficient of expansion permitting its use in combination with other essential metals; (5) capacity to resist the erosive action of the steam. If, in addition, the metal might be of a noncorroding nature, markedly resisting oxidation, it would be the ideal metal for superheated steam service.

Valve manufacturers, upon whom devolved the important necessity of producing devices to control and regulate the flow of the more powerful operating medium, were among the first to appreciate the inadequency of their former product to handle successfully high-pressure superheated steam. Cast-steel valves were necessary to replace the extra-heavy cast-iron ones suitable for steam pressures up to 250 lb. to withstand the increased steam pressures and the much more marked elevations in temperature without unduly adding to the weight of the valves. These valves, as in the case of iron-body valves, required seat rings, valve disks and other fittings and trim made of durable and noncorroding metal to assure tight closure in operation.

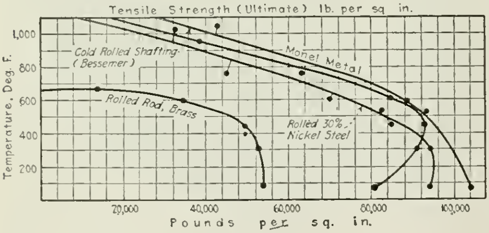


FIG. 1. BEHAVIOR OF MONEL AND NICKEL STEEL

The fittings for iron valves, usually of brass or bronze composition, are not suitable for cast-steel valve service, for the coefficient of expansion of cast steel is nearly double that of cast iron, brass or the bronzes used for valve fittings. The difference in the expansion of the valve-body metal and the valve fittings under the range of temperature encountered in high-pressure superheated-steam service would be such as to prohibit tight closure and produce serious deformation of valve seats, etc., at unusual temperatures. The difficulty was overcome by making the fittings for cast-steel valves out of monel metal, a natural alloy of individual characteristics, possessing a coefficient of expansion practically identical to that of steel. This monel metal is noncorrodible, strong as steel, tough and ductile. It takes and retains a high finish, is a better resistant to acid and alkaline corrosion than any of the common metals and is practically impervious to oxidation. It can be machined, forged, soldered and welded, both electrically and by the oxyacetylene process.

This metal is a natural product of the distinctive nickel and copper ores mined in the Sudbury district, Ontario, Canada. The ore is a basic igneous rock carrying sulphides of nickel and copper with pyrrhotite (magnetic pyrites) as constituents—the sulphides more or less segregated—and is smelted to matte form by a special roasting process that drives off the sulphur content without disturbing the balance of the main metal ingredients, copper and nickel. The process practically eliminates the sulphur content, and the matte, refined to get rid of impurities, produces a metal of unusual uniformity of composition—nickel, 67 per cent.; copper, 28 per cent.; and other elements, chiefly iron from the original ore and manganese, silicon and carbon introduced during the process of refining, 5 per cent.

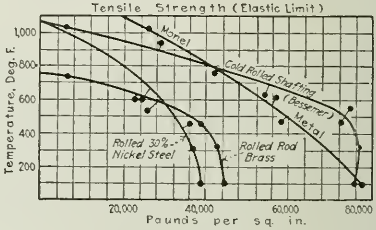


FIG. 2. ELASTIC LIMIT AT HIGH TEMPERATURES

The physical characteristics of the metal—it was not until 1906 that a practical method of producing monel metal was developed—are decidedly distinctive and individual. They are not and cannot, so far as known, be possessed in any like measure by synthetic mixtures of similar ingredients, for no mechanical process, so far as known, can produce the intimate combination resulting from centuries of geological formature.

The requisites for a metal to withstand the severe conditions of high-pressure superheated-steam service are apparently all possessed by monel metal, as evidenced by its physical properties. The one question remaining in doubt, or not conclusively established by the physical properties of the metal under normal conditions, is its ability to withstand effectively the universally weakening effect of high temperatures.

However, a series of comprehensive and exhaustive tests conducted by some of the leading valve manufacturers showed that in this respect monel metal is quite unique among metals in having its strength less influenced by elevated temperatures than any other known metal. Under any heat up to 1000 deg. F., its ultimate tensile strength in rolled form is considerably greater than that of any other metal ordinarily furnished in the form of rods. It is considerably stronger than

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*The International Nickel Co.

30 per cent. nickel steel at all temperatures and at high, as well as normal, temperatures is stronger than cold-rolled shafting bessemer. Even at 500 deg. F., at about which temperature cold-rolled shafting possesses its maximum strength, monel-metal rods are slightly the stronger. At the elastic limits of the various metal rods, monel metal possesses greater tensile strength than do rods of any other metal at temperatures exceeding that of about 800 deg. F. Below this temperature, bessemer cold-rolled shafting is somewhat the stronger at the elastic limits of the respective metals, but monel metal resists the action of corrosion and oxidation far more effectively.

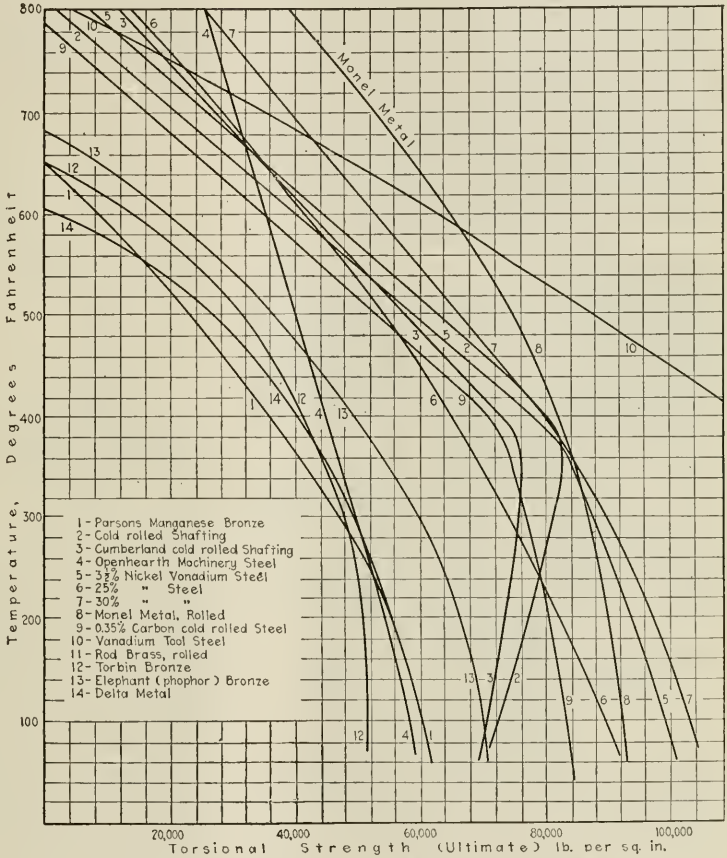


FIG. 3. BEHAVIOR OF MONEL AND OTHER METALS AT HIGH TEMPERATURES

Under torsion monel-metal rods are even stronger than bars of vanadium tool steel at temperatures in excess of 600 deg. F. and at all temperatures monel-metal rods are stronger than rods of nickel steel, any of the bronzes, cold-rolled shafting, machinery steel, delta metal, etc.

In the form of rods the metal is also of quite unusual importance in the power house. Monel-metal pump and piston rods, in particular, are highly economical, for they are more durable than steel or bronze rods and effect a substantial saving in power consumption and the use of packing. They do not score or pit and acquire a smooth, glassy surface in service that reduces friction to a minimum, avoids wear on the packing and eliminates to a great extent the leakage evil.

For parts of valves, in fabricated forms as bolts, nuts, screws, etc., for severe service and for use in connection with cast-steel mechanisms, monel-metal rods find many uses.

Another use of monel-metal rods, in which service the metal has also assisted in power-plant practice, is in connection with steam-turbine construction. The successful development of the steam turbine has been dependent to a considerable extent upon employing a suitable metal for the blades. A metal is required that will stand up well under the erosive action of high-pressure steam, resist corrosion, will retain strength at elevated temperatures and which can be worked easily into the required shapes. The first three requirements are essential and the last a matter of practical consideration.

There are three classes of metals—brasses, nickel steel and monel metal—that meet each of the four requirements to a certain extent and on that account have been quite extensively employed for steam-turbine blading. Brass can be worked into any required shape with little difficulty, it is noncorrodible and resists the erosive action of steam fairly well, but it lacks strength for use in large units and under a considerable temperature range loses much of its strength at normal temperatures. For instance, in superheated-steam service under high pressure it may lose as much as 40 per cent., or even more, of its strength at 70 deg. F.

Nickel steel does not possess the quality to resist corrosion or to withstand high-pressure steam erosion so desirable, if not absolutely essential, in a steam turbine. Its strength at ordinary temperatures is ample, but at a temperature in the neighborhood of 800 deg. F. it loses from 50 to 60 per cent. of its normal strength.

Monel metal can be worked easily into all necessary forms for turbine blading, resists corrosion and the erosion of high-pressure steam even better than does brass, on account of its high nickel content, is very nearly as strong as nickel steel at ordinary temperatures and resists the weakening influence of elevated temperatures far more effectively. At 800 deg. F., monel metal retains as much as 66⅔ per cent. of its strength at ordinary temperatures and is some 30, or more, per cent. stronger than nickel steel at the same temperature.

[We believe that readers may get the impression from the foregoing, that monel metal is more widely used for turbine blades than it actually is. It does make an excellent material for such service; but most builders, because of the expense, do not use it for turbines to the extent that might be inferred from the article. Nearly all builders agree that there is slight difference between the wearing qualities of a good nickel steel and monel metal. However, from a shop viewpoint, the chief disadvantage of the latter is that it is severe on dies and increases die charges. One of the largest builders of steam turbines in this country has never used monel for the blades except for one small single-wheel impulse machine in which the steam velocities are exceedingly high. This builder doubts that monel is as good for high-speed blades as pure nickel, which is now available. Great physical strength in the high-pressure blading in modern turbines is not vital. For the sake of efficiency all such blading, whether impulse or reaction, should operate at slow speeds, which result in low mechanical stresses. For the exhaust end blading where these stresses are high low-carbon, nickel, electric-furnace steel is widely used.—Editor.]

TABLE OF PHYSICAL PROPERTIES

Melting point of monel metal, deg.	1,360 C. (2,480 F.)
Specific gravity (cast)	8.87
Weight per cu.in. (cast), lb.	0.319
Weight per cu.in. (rolled), lb.	0.323
Coefficient of expansion (20 deg. C.—100 deg. C.)	0.00001375 per deg. C.
Electrical resistivity, 256 ohms per mil-foot. (temp. coefficient)	0.0011 per deg. F.
Electrical conductivity	4 per cent. (copper 100 per cent.)
Heat conductivity	1/15 that of copper
Shrinkage	¼ in. per foot
Hardness, cast material	20-23 (Shore scleroscope)
Hardness, hot rolled rods	27 (average shore scleroscope)
Hardness, hot-rolled rods	162 (average Brinell)
Modulus of elasticity	22,000,000-23,000,000

TESTS ON RODS

Tensile

Average respresentative tests of each of the three divisions as given:

	Yield Point, Lb. per Sq. In.	Ultimate Tensile Strength, Lb. per Sq. In.	Per Cent. Elongation in 2 In.
Up to 1 in.	63,126	94,562	40
$1\frac{1}{16}$ in. to and including $1\frac{13}{16}$ in.	61,963	93,104	39
$1\frac{3}{4}$ in. to and including $2\frac{7}{16}$ in.	50,115	87,678	42
$2\frac{1}{2}$ in. to and including $3\frac{1}{2}$ in.	43,805	85,282	44
Over $3\frac{1}{2}$ in.	47,335	84,763	43
Rectangles	56,353	85,562	42
Hexagons	60,736	87,781	40

Torsional (Average)

Shearing stress—lb. per sq.in. on remotest fibres:

At elastic limit	31,796
At ultimate load	79,053

Compression

Elastic limit	25,500 to 32,000 lb. per sq in.

TESTS ON CASTINGS

Tensile

Average of 172 heats tested for Isthmian Canal Commission:

Yield point	37,093 lb. per sq in.
Tensile strength	72,281 lb. per sq in.
Elongation in 2 in., per cent	34
Reduction of area, per cent	32

Compression

Elastic limit	12,000 to 25,500 lb. per sq.in.

Wattmeter Wrongly Applied

By E. C. Parham

In measuring the power taken by a three-phase motor from a three-phase circuit, it is customary to use two wattmeters, connected as shown in Fig. 1. With this connection, if the power factor is higher than 0.50, the total power absorbed will be the sum of the meter readings. Where only one wattmeter is available, the current coil is connected in series with one of the phase wires and one end of the potential coil is permanently connected to that phase wire, the other end being left free to be applied alternately to the other two-phase wires, as in Fig. 2. The sum of the two readings obtained gives the power absorbed. Where two meters are used, their readings will not be equal unless the load is strictly noninductive and balanced, because only then are the phase relations of the currents and voltages, acting on the meters, the same. It is therefore usually not correct to assume that the total power of the circuit is measured by twice the reading of an instrument that is actuated by the voltage and current of a single phase. In the case of two instruments that do not give equal readings, twice the reading of one would give a result too large and twice the reading of the other would give a result too small. It follows, then, that even when the load is evenly balanced on the three phases of a three-phase motor, the indication of a single wattmeter that is permanently connected to one of the phases cannot be taken as a measure of the total power supplied to the motor.

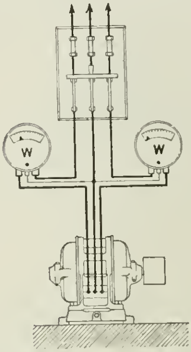


FIG. 1. CONNECTIONS WITH TWO WATT-METERS

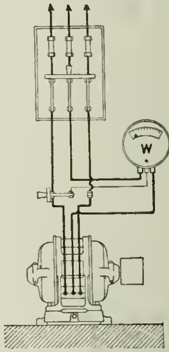


FIG. 2. CONNECTIONS WITH ONE WATT-METER

A certain three-phase induction motor was reported to be heating to a greater degree than its connected load would appear to warrant. It was stated that the trouble probably was in the motor because a wattmeter had been applied and it had indicated the motor to be operating at far below rated full load. By using two wattmeters an inspector determined that the motor was about 20 per cent. overloaded; also he found that it had absolutely no air circulation due to its ventilating ducts being stopped up with lint. Notwithstanding these conditions, the motor was not heating dangerously. In order to relieve the conditions the ventilating ducts were cleared and the operator built a tin chute by means of which air was directed onto the motor.

The reason why the operator's wattmeter measurement had indicated the motor to be very much underloaded was that he had connected the meter permanently to one phase and that happened to be the phase to which the lower-reading meter was connected when the inspector applied two meters. The multiplying of this reading by two would have given a result less than the full-load rating of the motor, but the operator's error was further increased by using 1.73 instead of 2 as a multiplier.

Only 125 American vessels were lost during the war, as compared with 3147 British—or 385,967 tons, as against 7,818,870 tons under the British ensign. Greece lost 162 vessels and Norway 781, both these neutrals suffering much more severely than the United States.

The Electrical Study Course—Introduction to Alternating Current

Discusses how the flow of an electric current through a circuit depends on the maintenance of a voltage across the circuit and gives hydraulic analogies of alternating and direct currents.

ELECTRIC currents as used for power and lighting are divided into two general classes, direct and alternating. The Electrical Study Course Lessons have, up to this time, been devoted almost exclusively to a consideration of the former class; treatment of the latter is inaugurated in this lesson.

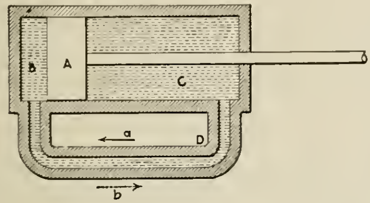


FIG. 1. HYDRAULIC ANALOGY OF ALTERNATING CURRENT

It was shown in the case of direct currents that a flow of current depended on the maintenance of a voltage; that is, it is necessary to have a difference in voltage between two points before current can flow from one to the other. Thus, in a generator, a voltage is caused to exist across the terminals of the machine by rotating the armature in the magnetic flux of the field. Whether current flows, and if so, how much, depends upon providing a path for the current, such as a resistance, or lamps, or motors, connected between the terminals, and the magnitude of the current is controlled by the load so connected. If no load is connected no current will flow, although the voltage exists across the terminals just the same. It is therefore apparent that a voltage may exist without a flow of current, but an electric current cannot exist unless there is a voltage present to cause the flow. These conditions are similar to those found in a hydraulic system. We may have a pump furnishing water at a certain pressure. If the outlet valve is closed, the flow of water will cease but there will still be pressure at the pump. On the other hand, if the pressure is zero, there can be no flow of water even though the valves be wide open.

It is of great importance to establish firmly in one's mind the foregoing fact; namely, that flow of current is dependent upon the presence of voltage. It holds true for alternating currents as for direct; that is, in order to have an alternating current we must first have a source of alternating voltage. It will therefore be logical to treat of alternating voltages before concerning ourselves with the currents caused to flow by them.

The usual method of producing an alternating voltage is to employ a generator as in the case of a direct voltage. Such generators are often called alternators. There are various forms of them. The smaller sizes are often of a design identical with that of the direct-current type with the exception that the armature winding is connected to slip rings instead of a commutator. In fact, any direct-current generator could be used as an alternating-current machine if slip rings were provided and connected to the armature winding in the proper manner. In this regard we can refer back to the discussion on the direct-current generator, in which, it will be remembered, it was found that it is really an alternating voltage that is generated and that the purpose of using a commutator is to rectify this alternating voltage into a direct one. In addition to this type, which is familiar to us from our direct-current studies, there is a type of alternator—and it is the one used almost exclusively for machines of any considerable size—in which the armature is stationary and the field revolves. This type will be treated of subsequently. For the purpose of studying alternating voltages we shall confine ourselves to the type of machine with which we are familiar; namely, that in which the field is stationary and the armature revolves.

Before actually taking up the development of an alternating voltage in such a machine, it will be necessary to investigate what is meant by the word "alternating" when applied to an electric voltage or current. For this purpose let us go back to a consideration of the hydraulic analogy. Suppose that we have a plunger pump with its cylinder ends connected through a system of piping, as shown in Fig. 1, and that the cylinders and pipe are completely filled with water. Then, when the piston *A* is pulled to the right, water will flow from *C* to *B* through the pipe *D* in the direction of the solid arrow *a*. When piston *A* reaches the end of its stroke, the flow of water will cease momentarily, and then, as the piston begins to move in the opposite direction—that is, to the left—water will flow from *B* to *C* in the direction of the dotted arrow *b*. As *A* approaches its limit of travel to the left, the flow of water will again stop, to be resumed in the same direction as at first when the piston once more begins to travel to the right, It is apparent that for each stroke of the piston the direction of flow in the pipe *D* is regularly reversed. Such a flow would be called alternating.

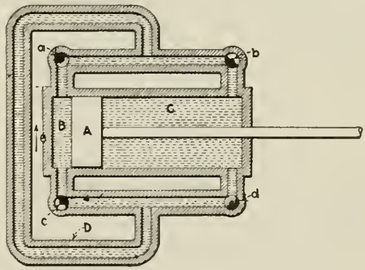


FIG. 2. HYDRAULIC ANALOGY OF DIRECT CURRENT

If the arrangement were that shown in Fig. 2, the flow in the pipe would always be in the same direction if the valves *a*, *b*, *c* and *d* operated correctly. In the figure the piston *A* is ready to move to the right and the valves *a* and *d* are open to allow the water in *C* to be forced into *B*, causing it to flow in the direction of the arrow *e* through the pipe *D*. The other valves, *b* and *c*, are closed and remain so until the piston *A* has reached the end of its stroke, whereupon they are opened and *a* and *d* closed. On its return stroke *A* would then force water from *B* into *C* through the valve *c*, pipe *D* and valve *d*, in the same direction through *D* as before. Thus the flow in the pipes is always in the same direction and may therefore be called a direct flow. Hence, the valves may be looked upon as serving the purpose of a commutator for rectifying the alternating current of Fig. 1 into the direct one of Fig. 2.

The steadiness of flow in Fig. 2 depends on the action of the cylinder and the time required for the reversal of travel, and it will therefore be more or less pulsating in character, but nevertheless always in one direction. A like condition obtains in the case of Fig. 1; that is, the character of flow and its reversal depend upon the characteristics of the steam pump. This idea can be carried still further and can be applied to electrical pressures or voltages, instead of to water or steam pressures, as will be shown in the following lesson.

In the problem of the preceding lesson it was required to construct the efficiency curve of a motor, having given the results of a brake test as contained in the table herewith, and that the effective pulley diameter is 8¼ in.

Reading No.	*E* Volts	*I* Amperes	*S* R.P.M.	W_1 Lb. Oz.	W_2 Lb. Oz.
1	110	12.5	1200	24-06	10-05
2	110	25.0	1150	58-15	19-12
3	110	37.5	1100	92-11	27-07
4	110	50 0	1050	131-12	35-03
5	110	62.5	1000	170-05	43-10

We first find the outputs for the various readings from the formula, $hp. = \frac{\pi \times D \times S \times (W_1 - W_2)}{33{,}000 \times 12}$, in which *hp.* represents the output in horsepower, $\pi = 3.142$, *D* represents the effective pulley diameter in inches, *S* the speed in r.p.m., W_1 the indication of the beam scale in pounds, W_2 that of the spring balance in pounds, and in which 33,000 is the number of foot-pounds per minute in one horsepower, and 12 is a factor for reducing *D* from inches into feet. Since all the quantities except *S*, W_1 and W_2 are constant, we may write

$$hp. = \frac{\pi \times D \times S \times (W_1 - W_2)}{33{,}000 \times 12} = \frac{3.142 \times 8.25 \times S \times (W_1 - W_2)}{33{,}000 \times 12}$$

$= 0.00006546 \times S \times (W_1 - W_2)$. Then, substituting the values of the various readings will give us the value of *hp.* corresponding to each. Thus, for reading No. 1 we have $hp. = 0.00006546 \times 1200 \times (24\text{-}06 - 10\text{-}05) = 1.105$. Making a similar computation for each of the other readings gives the results contained in the third column of the table herewith:

Reading No.	Input Hp.	Output, Hp.	Efficiency Per Cent.
1	1 843	1.105	59.96
2	3 686	2 950	80 03
3	5.529	4 699	84.99
4	7 373	6 638	90.03
5	9.216	8.294	90 00

The horsepower inputs are obtained by multiplying the volts by the amperes for each reading and dividing by 746. That is, *horsepower input* $= \frac{EI}{746}$. Applying this to reading No. 1, we have, *horsepower input* $= \frac{110 \times 12.5}{746} = 1.843$ *hp.*, and by making a like substitution for the remainder of the readings we obtain the results entered in the second column of the table of results. To determine the efficiencies, as given in the last column, the values in column 3 are divided by the corresponding ones of column 2, and the result multiplied by 100 to convert it into percentage. Then the efficiency curve is constructed from the values in the third and last column as shown in Fig. 3.

A 50-hp. motor whose rated speed is 1000 r.p.m. is to be tested for efficiency up to 25 per cent. overload, by means of a prony brake. The platform scale available for the test has a maximum capacity of 200 lb. What is the shortest length of arm that the brake could be designed for?

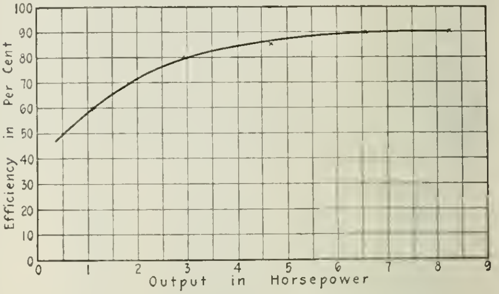


FIG. 3. EFFICIENCY CURVE FOR MOTOR

Improved Girtanner Ash Conveyor

Most large power plants utilize some kind of ash conveyor in conjunction with their boiler plant. Many of these are actuated by one or more steam jets which draw the ashes through a horizontal pipe and discharge them through a vertical pipe into an ash tank. The ashes and clinker quickly wear through the metal of the pipes, especially at the bends, and various devices have been used to reduce this trouble.

Several improvements have recently been made to the Girtanner ash conveyor, manufactured by the Girtanner Engineering Corporation, 1400 Broadway, New York City. Beginning at the air intake on the inner end of the ash pipe, an iron grating is supplied to prevent foreign materials from falling into it. The opening of the intake member is made 50 per cent. greater in area than the pipe. The horizontal pipes are now made in 18-, 24,- 30-, 36-, 48-, 60- and 72-in. standard lengths. This facilitates making up a system quickly with suitable lengths, thus avoiding the necessity of making a special length for any particular installation. These lengths are made with a flange at each end and are bolted together by ⅞-in. bolts. The joint is made tight by means of a ½-in. round asbestos gasket that fits in a diamond-shaped groove cast in the face of the flange. When the flanges are brought metal to metal a ⅛-in. space is left between the upper flange faces outside the gasket. This is to permit the gasket to squeeze out on this side and thus make a tight joint.

A clever idea has been worked out in the design of the ash intake openings. These openings are usually desired opposite the center of the boiler setting. In order to bring them there an intake tee has been designed 36 in. long with the intake opening 3 in. out of center. Thus if the center of the intake opening is 3 in. short of the desired position, the intake tee can be turned end for end. In case this does not bring the opening in the desired position the difference can be adjusted by means of the cover plate, the opening in which is also out of center and has an adjustment of 1½ in. by turning the plate end for end. The joint between the cover plate and the intake tee is made with asbestos gaskets that fit in diamond-shaped grooves. This arrangement permits of any adjustment within one inch at any part of six feet. An intake cover fits in the cover plate, the top coming level with the flooring and the inside being fitted with a curved plate that completes the circle of the pipe, thus preventing a pocket at the covers.

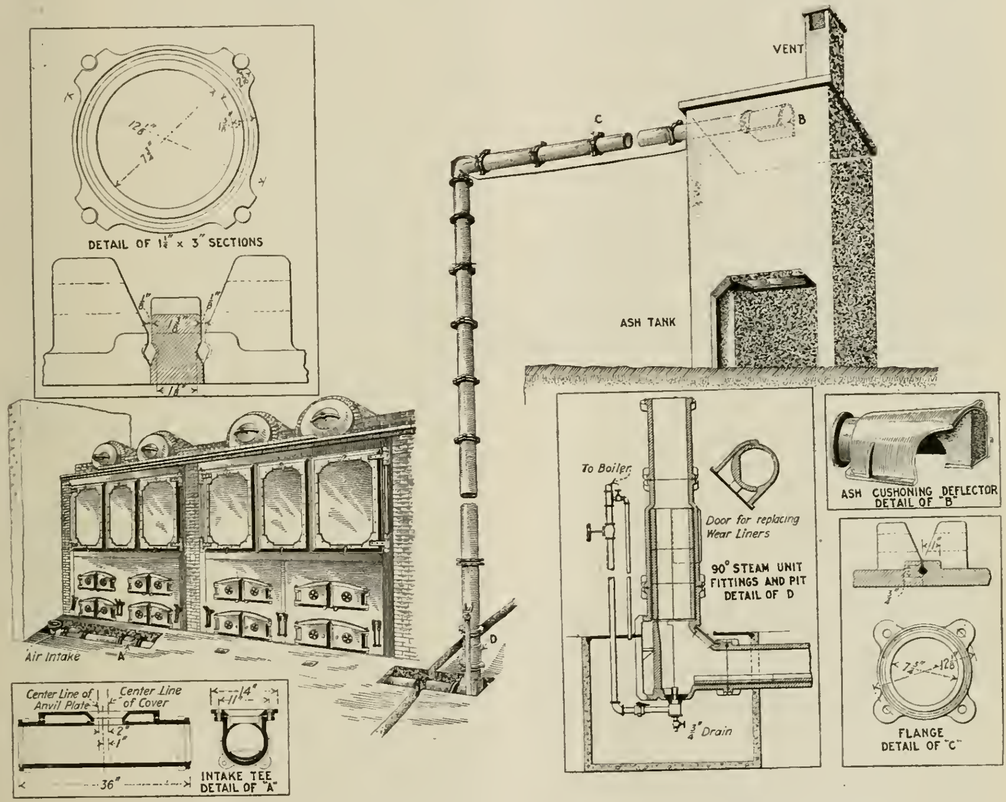
The entire bottom of the horizontal pipe is reinforced by liners, made in 18- and 24-in. lengths, which are inserted into the pipe through the intake openings. When worn out they are removed through the same opening.

Where the pipe turns from the horizontal to the vertical a special elbow is used. This is fitted with an inspection door through which a target plate is placed to receive the impact of the heavier pieces of ashes and clinker. A section of vertical pipe is bolted to this elbow and it is lined with split metal bushings, each 8 in. long; the lower one resting a shoulder in the elbow also forms a joint with the target plate. These four-piece bushings can be removed and replaced when worn, through a door in the vertical section of pipe, which is made of such diameter that the liners maintain the same inside diameter as the main pipe itself.

At the bottom of the elbow a steam nozzle is fitted in a plug. The nozzle is hexagon so that it can be removed for examination or replacement through an opening without breaking the steam pipe connection. It can also be removed from the outside of the elbow, but the steam connection would have to be broken. Water that may accumulate in the system is automatically discharged through a specially designed valve in the pocket that is formed for the reception of the nozzle.

In case it is necessary to remove the elbow and vertical liner section, provision has been made for holding the riser pipe in position. This is accomplished by two upright columns, one end resting on a suitable foundation; the other end of each is fitted with a plug in which a screw is fitted. This screw also fits into a lug cast on the upper section of the riser, and by screwing down the lower nut the weight of the vertical pipe is sustained by these columns. The lower sections are then easily removed.

On top of the ash bin a deflector box is arranged on the end of the pipe. This is capped at the outer end, and to prevent the cap from being worn through a shelf is cast on the inside bottom of the box and on this the ashes pile. This accumulation of ashes soon fills the end of the box, thus protecting the head with a baffling of ashes. The head is removable and is bolted to the deflector box.


DETAIL OF 1¼" × 3" SECTIONS
12⅞"
1⅛"
1¼
VENT
C
B
ASH TANK
To Boiler
Door for replacing Wear Liners
90° STEAM UNIT FITTINGS AND PIT DETAIL OF D
¾" Drain
ASH CUSHIONING DEFLECTOR DETAIL OF "B"
7⅞"
12⅞
FLANGE DETAIL OF "C"
Air Intake
A
D
Center Line of Anvil Plate
Center Line of Cover
2"
1"
36"
14"
11"
INTAKE TEE DETAIL OF "A"

GENERAL LAYOUT OF ASH-HANDLING SYSTEM AND DETAIL OF IMPROVED PARTS

Sudden Peak Loads on Chain-Grate Stokers

By H. F. GAUSS

Pertinent features affecting the design and operation of chain-grate stokers, with a chart for determining the proper air supply for fuels of various heat values.

AMONG power-plant equipment no piece of apparatus is attracting more attention at the present time than the forced-draft stoker. The term "normal rating" as applied to a steam boiler no longer limits its capacity, and is retained principally as an index to the amount of heating surface contained. Continuous operation of steam boilers at from 200 to 300 per cent. normal rating is now common, and stoker installations must be designed to burn sufficient coal to produce this rating.

There are two general classes of power-plant installations: Those having a steady or uniform load throughout their operation and those subject to extreme peak loads that must be met on short notice. The larger number of installations fall in the second class. A frequent complaint heard in boiler rooms is, "They slam on certain equipment all at once and without warning, and there's the devil to pay to hold steam." So it is squarely up to the designer to produce boiler and stoker equipment that will successfully handle emergencies of this nature.

Air Supply and Grate Area

The problem presented by the plant with a steady load resolves itself into a question of air supply and grate area. Perfect combustion is secured by properly mixing the correct amount of air with the fuel to be burned in the proper place and at the proper temperature. Failure on the part of such an installation must be due to incorrect air supply or insufficient grate area.

The plant with the peak load to meet, presents an additional problem. It must be capable of picking up a sudden extreme load easily and quickly, which can be accomplished only by increasing the rate of burning fuel on the grate. Proper manipulation of the feed water and auxiliary apparatus will help in the initial stage, but the primary object that must be accomplished is the burning of sufficient fuel at a sufficient rate to produce the necessary heat for generating steam to meet the demand. Again, there are but two causes for failure on the part of the stoker, and they are insufficient air and insufficient grate area.

There is a limit to the velocity at which air can be successfully forced through a grate. A certain time element is essential to the maintenance of the combustion temperature, and the proper mixing and contact of the air with the fuel and unburned gases liberated. When air moves so rapidly through the grate that this time element is not provided, the fire is blown out instead of the combustion being aided.

It is possible to blow out a fire by jetting through it a supply of air in itself insufficient for proper combustion, but driven through the grate at such a high velocity that combustion has not time to take place before the fuel is cooled below the point of ignition. This condition frequently obtains when high rates of combustion are attempted with forced-draft stokers by raising the pressure in the windbox until the air is forced through insufficient openings in the grate at high velocities. Given a grate with a certain percentage of air space, there is then a limit to the amount of a certain kind of fuel that can be burned on it. Therefore, to meet a sudden peak load a grate must have a percentage of air space and an area such that the necessary rate of combustion can be obtained with the air flowing through the grate and fuel bed at velocities low enough to permit of proper combustion. The question at once arises, What is the limiting air velocity?

No definite formula can be given for finding this limiting velocity because a number of factors affect the solution. They are principally the character of the fuel and the means provided for dissipating the air through the fuel bed. Again, the stage of combustion has a great deal to do with the velocity at which air may be delivered to a fuel bed. During the early or ignition stages there is much more danger of blowing out the fire by excessive air velocity than after the volatile has largely been driven off and the carbon has reached incandescence; hence the necessity of controlling the air supply to the progressive zones of the grate. In fact, in burning certain grades of fuel such as lignites and anthracite culm on chain-grate stokers, it has been found advantageous to introduce an induction zone for igniting the fuel. Directly under the ignition arch is a section of the stoker provided with a tuyere by which some of the hot gases from the furnace can be drawn down through the green fuel, which is thus ignited, the induction fan discharging its gases into the succeeding pressure zones.

Control of the Air Supply

Evidently, the term "rate of combustion per square foot of grate area" means very little when it is determined by dividing the total fuel burned per hour by the total grate area. An important part of successful stoker design is to get the fuel ignited and burning while in the ignition zones of the furnace, so that after it has reached the real combustion zones, no time is lost in igniting green fuel and the necessary high rate of combustion can be obtained. For instance, consider a forced-draft chain-grate stoker 12 ft. long. The stages of ignition, release of volatile matter and combustion of fixed carbon must take place in the order named and the time necessary for each must be properly provided. During the early stages the weight of fuel consumed is relatively small, in the middle stages it is high and in the last stages it again becomes low. In a stoker burning fuel at a rate of 75 lb. per square foot per hour the actual maximum rate may be as high as 150 lb. per sq.ft. of grate area in the middle zones of the stoker. This emphasizes the necessity of perfect control of the air supply to the successive zones, and also illustrates the fact that air can be successfully driven through certain sections of a stoker grate at much higher velocities than through other parts of the same grate.

There is another important consideration in determining the amount of air necessary for the required rate of combustion. An increase in velocity of air passing through the grate is at the expense of an increase in static pressure in the windbox. To deliver a greater quantity of air against an increased pressure an increase in fan speed is necessary. A condition may easily be reached whereby the windbox pressure is raised to such a point that less air is actually delivered but at a much higher velocity. For instance, the accompanying table, copied from a blower catalog, shows that a 16-in. fan running at 2750 r.p.m. will deliver 5400 cu.ft. per min. of air against a static pressure of 0.5 in., and at a speed of 3250 r.p.m. it will deliver 6400 cu.ft. per min. against the same pressure. At the increased speed the same fan will deliver only 5500 cu.ft. per min. against a pressure of 1 in. and 4600 cu.ft. per min. against a pressure of 1.5 in. Hence it will not do to assume that since a fan has a certain range of capacity it will be capable of supplying these quantities of air against a static pressure of 0.5 in. through a grate, with the resultant rates of combustion, because the increase in air velocity can be obtained only by increasing the static pressure of the windbox.

It is therefore essential that the grate itself be provided with sufficient air space to permit the maximum amount of air to pass at a predetermined static windbox pressure, and that lower rates be obtained either by reducing the windbox pressure or by providing dampers to limit the volume of air allowed to pass from the windbox through the grates, which of course will raise the windbox pressure, assuming that the fan is run at the same speed.

The accompanying chart makes it possible to find the area of air space required for a given boiler output, taking into account the various factors. For example, suppose that it is desired to find the air-space area in the grates of a boiler of 850 hp. burning fuel having a heat value of 10,000 B.t.u. per lb. and operating at an efficiency of 70 per cent., assuming 50 per cent. excess of air and an air velocity of 2100 ft. per min. Using the alignment chart in the blank space at the right, locate 70 on the scale of boiler efficiency and 10,000 on the scale of heat value and join the two by a straight line, continuing it until it cuts the right-hand scale. The point thus found on this scale will represent 4.8 lb. of fuel per boiler horsepower-hour.

On the lower line of the upper right-hand quadrant locate 4.8 and proceed vertically to the diagonal marked

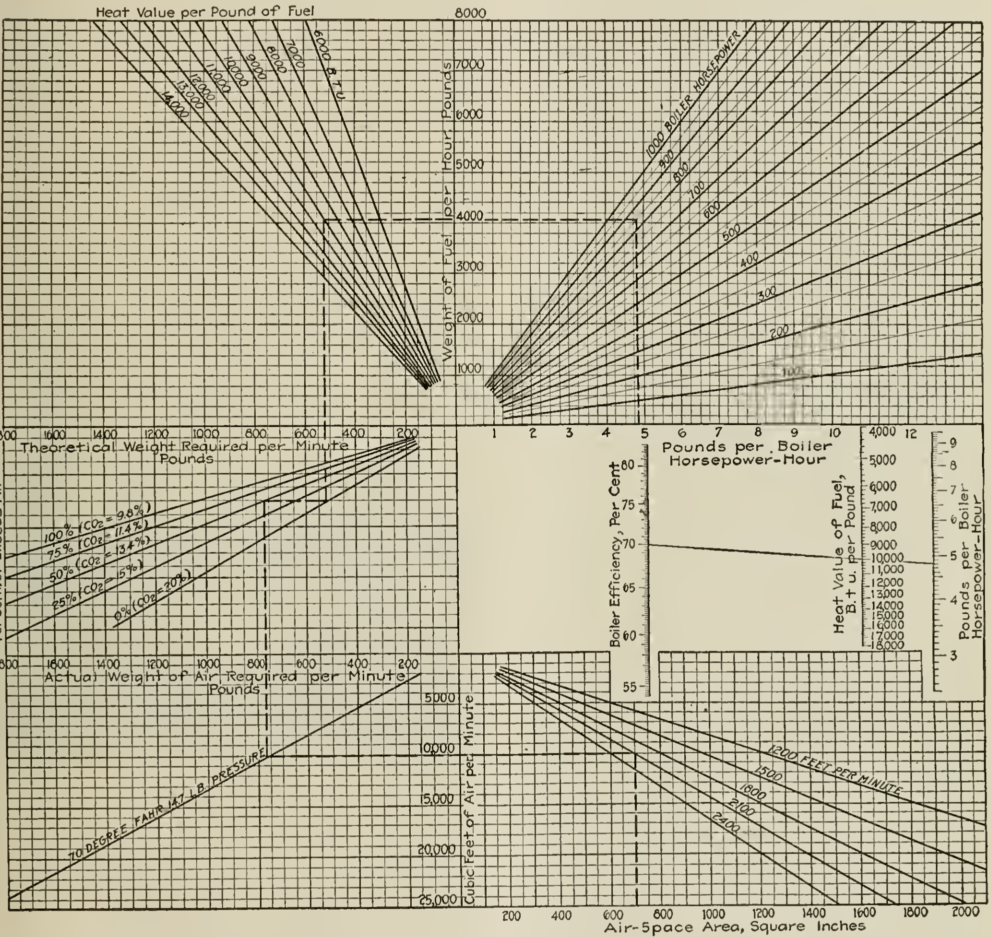


CHART FOR FINDING AIR-SPACE AREA FOR A GIVEN BOILER OUTPUT

850 boiler horsepower. Then turn horizontally to the diagonal representing 10,000 B.t.u. in the upper left-hand quadrant. From this point drop vertically to the diagonal representing no excess of air (20 per cent. of CO_2) and then follow horizontally to the diagonal representing 50 per cent. excess of air. Thence drop vertically to the diagonal in the lower left-hand quadrant, and then turn horizontally to the lower right-hand quadrant until the diagonal representing an air velocity of 2100 ft. per min. is reached. From this last point drop vertically to the bottom scale, where the value 700 will be indicated, meaning that an air-space area of 700 sq.in. is required.

TABULAR DATA AND GRAPHIC CHARTS AVAILABLE

There is much information available at present in the shape of tabular data and graphic charts giving the draft required to burn various kinds and grades of fuel on various types of grate. The information thus obtained is valuable and can be used as an index to the pressure in the windbox or draft over the fire required. In the final analysis, however, the air space in the grate must be considered, as it is possible that the amount of air required for the rate of combustion desired cannot be forced through the grate at reasonable velocities, and when the fuel bed is added with its resistance, failure inevitably results. Herein is the principal cause of failure of stokers to pick up peak loads promptly. The air is available, but it cannot be delivered to the fuel bed at velocities to produce the necessary combustion.

In general, it may be said for forced-draft stokers that by far the most desirable condition is a grate so designed that a sufficient volume of air can be delivered through the fuel bed at a static pressure in the windbox of never to exceed 1.5 in. This of course would limit the fuel bed to a thickness of not more than 12 in., which in itself is a desirable feature, inasmuch as the formation of large clinkers is not as common with these thinner fuel beds as it is with very thick ones, and the percentage of carbon in the ash from a thin fuel bed has been found to be materially less.

No more serious mistake can be made in the selection and design of a stoker than the assumption that forced draft will eliminate the necessity of a large stack. The practical limit of forced draft is a balanced condition in the furnace, and preferably a few hundredths of an inch of draft rather than pressure. From this point on the chimney must do the work. The fan producing forced draft overcomes the resistance of the grate and fuel bed, but cannot go farther without the danger of excessive blowing out through unavoidable crevices in the setting and filling the boiler room with disagreeable smoke and dangerous gases. The height of the stack can be reduced by an amount necessary to produce draft enough to pull the air through the grate and fuel bed, but no more, and its diameter must be sufficient to handle the volume of gases evolved. The only advantages accruing from the use of forced draft are the gain by establishing a balanced condition in the furnace and reducing the leakage of cold air into the furnace through unavoidable crevices and the easier means of controlling the amount of air delivered through the grates, which in turn facilitates the picking up and dropping of peak loads.

One of the problems in the operation of stokers is the disposal of ash in such a way that the formation of large clinkers will be avoided. The violent agitation of a fuel bed tending to mix the ash with unburned fuel is sure to produce clinkers, which fuse around unburned coal, preventing its final combustion and resulting in a high percentage of carbon in the ash. This result can be seen easily by breaking open a large clinker and inspecting the fracture.

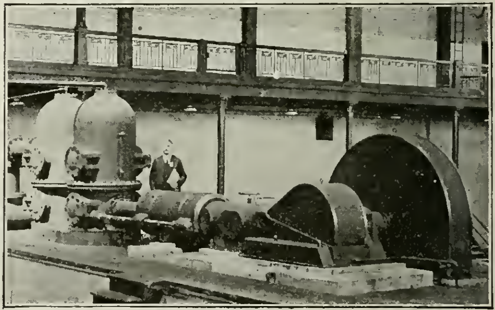
Chain- and traveling-grate stokers are perhaps the only types that do not produce clinkers of this kind. In the chain-grate, however, some means of keeping the side walls cool just above the top of the fuel bed is desirable to prevent the adherence of ash to the side walls. The ash tends to build outward over the grate, forming a clinker that obstructs the movement of the fuel and bares the grate behind it. Cooling of the side walls has been effected successfully by means of water-cooled clinker plates.

SPEED, PRESSURE AND VOLUME OF AIR DELIVERED BY 16-IN. FAN

Speed of Fan, R.p.m.	Static Pressure, Inches of Water							
	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00
	Volume of Air Delivered, Cubic Feet per Minute							
2750	5800	5400	4900	4400	4100	3600	3100	. . .
3250	6700	6400	6000	5500	5100	4600	4200	3800
3750	7600	7300	6900	6500	6100	5700	5350	5000
4250	8500	8200	7900	7550	7200	6800	6400	6100

"Unaflow" Pumping Engine

Those who attended the recent convention of the American Water Works Association at Buffalo were afforded an opportunity of seeing at the Porter Avenue pumping station a 3,000,000-gal. "Unaflow" pumping engine. This is of the horizontal type having one steam cylinder and one double-acting plunger pump. Its normal working water pressure is 100 lb. per sq.in., and the suction lift is approximately 15 lb. plus the friction in about 60 ft. of pipe. The pressure on the steam end is 235 lb. and 100 deg. superheat.



"UNAFLOW" TEST PUMPING ENGINE AT BUFFALO

To develop a pump that could be combined with and utilize the advantageous features of the "unaflow" principle required that due consideration be given to proper channels for passing the desired amount of water to and through the pump with the least practicable amount of deflection and disturbance of the flow. The pump must be provided with passages ample and direct, so that there will be no reversal of flow; with plungers properly proportioned and formed to cause a minimum disturbance; with suitable suction and discharge air chambers properly located; with pump valves that will deflect the direction of flow as little as possible, that will operate quickly and quietly at all pressures and economic speeds of the engine, and, furthermore, that will be durable and lasting in operation. Tests of this engine will be made later and the results made public.

EDITORIALS

What Should Be the Maximum Length of a Longitudinal Joint in a Boiler?

THE Massachusetts Board of Boiler Rules prescribes that:

> A horizontal return-tubular, vertical-tubular, or locomotive-type boiler shall not have a continuous longitudinal joint over twelve (12) feet in length.

The Boiler Code of the American Society of Mechanical Engineers says:

> In horizontal return-tubular boilers with lap joints no course shall be over 12 ft. long. With butt-and-double-strap construction longitudinal joints of any length may be used, provided the test specimens are so cut from the shell plate that their lengthwise direction is parallel with the circumferential seams of the boiler and the test meets the standards prescribed in the specifications for boiler-plate steel.

The restriction in length applies in the Massachusetts Rules to three types of boilers—horizontal return-tubular, vertical-tubular and locomotive—whether the joint is of the lap or butt-and-strap type. In the A. S. M. E. Code it applies to only one type of boiler, the horizontal return-tubular, and to that only when a lap joint is used.

Both Rules and Code inhibit the use of a lap-riveted longitudinal joint over twelve feet in length on a horizontal return-tubular boiler.

Under the A. S. M. E. Boiler Code a butt-and-strap joint of any length may be used on any kind of a boiler. In Massachusetts such a joint may not be over twelve feet long on a horizontal return-tubular, vertical-tubular, or locomotive boiler.

No restriction is placed by either authority upon the length of longitudinal joint that may be used in the shell or drum of a water-tube boiler. Is this because they do not come in contact with the fire and are not subject to such severe temperature changes? But neither does the shell of a vertical-tubular or locomotive boiler.

What is it that makes a joint over twelve feet in length dangerous? The makers of the A. S. M. E. Code seem to suspect that on account of the limited number of mills having wide rolls and the consequent difficulty of getting very wide plate, the boiler manufacturer may roll the plate endwise in order to get a long course and thus put the tensile stress upon it crosswise of the grain. Some of those who have discussed the subject compare the weakness caused by a long joint in a boiler to that caused by a long uninterrupted course in masonry and urge that it is better to break the line occasionally, without being very specific as to the kind of weakness produced and the manner of producing it.

Boiler-insurance companies say that their records indicate that the long joint is a source of weakness and has been the cause of numerous explosions.

It would be very satisfying if we could have some information as to just what happens with a long joint; whether the dangerous tendencies introduced by its length are counteracted by making it of the butt-and-double-strap construction, as appears to be assumed by the makers of the A. S. M. E. Code, or if these perversities persist even in that type of joint, as appears to be feared by the Massachusetts Board of Boiler Rules. If long joints are dangerous upon vertical and locomotive boilers in Massachusetts, they are dangerous anywhere. Either the Massachusetts Rules are too exacting or the A. S. M. E. Code is too lax.

This is one of the main points of difference between the Massachusetts Rules and the A. S. M. E. Code. It is not a political or geographical but a plain engineering question. If one or the other position is not so decidedly stronger than the other that it can be so proved in a clean, unbiased engineering argument, then in the interest of harmony and efficiency and uniformity there ought to be a compromise which will wipe the difference out, for it is not of enough importance to remain as a split in American practice. If one view is capable, by engineering argument, by the statistics of explosions or by other means, of being demonstrated the more correct, it should be written into both codes regardless of what they have decreed or been satisfied with in the past.

Let us have a plain engineering discussion of the question, Why Is a Long Longitudinal Joint Dangerous? What do you know or think about it? If we can find this out, we can better decide whether it should be allowed upon vertical and locomotive boilers, and whether its dangerous proclivities are obviated by making it of the butt-and-strap type. It is to everybody's advantage to clear up the points of difference between the two codes.

Superheated Steam—Why Not?

WHAT are the advantages in using superheated steam? Can it be used successfully with reciprocating engines of the Corliss and slide-valve types? Have lubricating troubles been overcome when using superheated steam with reciprocating units, and, if so, how? Will engines having ordinary cast-iron cylinders and valves withstand the effects of superheated steam?

These are pertinent questions in which the steam engineer of today is interested. The average engineer will state that the superheated steam is confined to steam-turbine power plants, that the use of superheated steam in reciprocating engines is confined to those having the poppet type of valve, and that its use with the ordinary type of reciprocating engine is not general.

It would be difficult to determine the exact percentage of power plants using superheated steam, but it is assumed that of the total horsepower developed in this country by steam, perhaps only thirty per cent. is developed by units using superheated steam, and this is mostly confined to steam-turbine plants. Thus, it is evident that although most turbine plants employ superheated steam, the number of such plants is a comparatively small percentage of the total steam plants. In other words, approximately seventy per cent. of the steam power developed in this country is produced by units using saturated steam. Why should this be?

Two arguments have been advanced against the use of superheated steam in reciprocating engines; namely, difficulty of lubrication and the inability of the metal commonly used in making the cylinders and valves to withstand the high temperature. But is it not a fact that suitable oil is procurable for use with high-temperature steam and that proper means for lubrication is available? Furthermore, is it so much the metal of which a cylinder and its valves are made as it is the degree of care that is exercised in the maintenance and operation of reciprocating engines when using superheated steam?

As a matter of fact, one manufacturer of superheaters states that in the application of over eighteen million horsepower in superheaters for stationary, marine and locomotive service, he has found that from two hundred to two hundred and fifty degrees superheat can be safely and satisfactorily employed with successful lubrication and without material change in the metal used in the cylinder valves, fittings and pipings.

It has been several years since the subject of using superheated steam has been discussed in technical journals to any extent, and it would seem that in view of the present coal situation and the consequent desirability of effecting economy wherever possible, there is still much to be desired in the adoption of superheat in plants operating reciprocating engines.

Undoubtedly, there are some of our readers who are operating reciprocating engines and using superheated steam. It would be of interest to other readers to know just what troubles they have had, how they have overcome them, and general data regarding the use of superheat in their plants, how they have solved the lubricating question, and how the material of which the engines are made has stood up under the high temperature.

Material for Turbine Blades

IF THE steam and speed conditions that turbine blades have to serve under were always the same, some one metal for their construction might be found and used. But conditions widely vary, and therefore a wide variety of materials are used. There is not a turbine builder here or abroad who would not be overjoyed to find, "the very best material." But a standard material has not been found.

Elsewhere in this issue appears an article which in part treats of this subject with particular references to monel metal. It brought the question of turbine-blade materials again before us, and the present practice, as told in communications from nearly all the builders in this country, is of interest to all power-plant men.

Richard Rice, of the General Electric Company, well expresses the matter when he says: "There are a number of materials which are eminently suitable for use as turbine buckets, and the use of these materials depends entirely upon the steam conditions and the particular place where the buckets are to be used, the stresses in the buckets, both centrifugal and bending, also upon the cost of the material, not raw but in the condition of a finished bucket."

W. J. A. London, of the Steam Motors Company, who has had considerable experience in steam-turbine design in America, the British Isles and on the Continent, says, " . . . as far as I have been able to find out the best experts in steam-turbine design in this country or in Europe are about as much up in the air as to what to use for turbine blading as they ever were." In 1913 he found in Germany no two shops using the same material. The materials used ranged from thirty per cent. nickel steel to soft Swedish iron. Experience has convinced Mr. London that for impulse blading, generally speaking, soft steel or iron is admirably suited. Relative to monel metal he says that difficulties are had in getting uniformity in characteristics. These were experienced by the builders of the Parsons turbines in England; and Mr. London believes the United States Navy's experience with monel for propellers has demonstrated that certain consignments of the metal are satisfactory, but the quality of this metal, being a natural alloy, is erratic in its characteristics. But, the tendency of practice is toward higher pressures, temperatures and stresses, and for these monel is one of the materials excellently suited. Mr. Rice points out that for high superheat and where the centrifugal stress or the combined centrifugal and bending stresses are extremely high, there is nothing equal to some steel alloy having a high elastic limit. The cost, of course, is high.

Experience is showing that phosphor-bronze blading for reaction machines under high pressure and superheat lives up unexpectedly well. For example, in the high-pressure stages of a large Westinghouse type machine in one of the Chicago stations where two hundred and forty pounds pressure, gage, is carried at the throttle, with two hundred degrees superheat, no appreciable evidence of corrosion or erosion is apparent after a year's operation. In the exhaust-end blading, where the mechanical stresses are high and the temperatures low, low-carbon, five per cent. nickel electric furnace steel is performing satisfactorily in machines of this type. Of monel, J. T. Johnson, engineer, turbine department of the Westinghouse Electric and Manufacturing Company, says: "The cost of the metal and of manufacture of the blades is considerably higher than the cost of steel or bronze blading. It is probably not any cheaper nor as good for high-speed blading as pure nickel, which is now available." Mr. Wallace, of the De Laval Steam Turbine Company, makes the point that it (monel) is severe on dies.

Maynard D. Church, chief engineer of the Terry Steam Turbine Company, points out that a turbine that stands idle much of the time should have its blades of such material that the edges of the blades will not be rusted away, thus greatly impairing the machine's efficiency. In velocity-stage machines he finds monel among the very best for the first moving row of blades, following this with copper-nickel alloy, with extended brass for the low-pressure blades of condensing machines.

It is our understanding that the Fore River Shipbuilding Company is now making large quantities of monel blades by machining them out of the solid square stock.

So one sees that the art has not yet got where it can be said that any one material is standard.

When cutting in a boiler to a header, care should be exercised. The steam pressures should agree before opening the valves, and they should then be opened slowly.

Is there anyone about your plant who is interested in the amount of coal in the ash pile?

Correspondence

Difficulty Experienced in Getting a Generator up to Full Voltage

In the issue of *Power* for Apr. 22 appears a letter from Robert Tomlinson asking for an explanation of the strange behavior of a compound-wound generator. Consideration of all evidence leads to the conclusion that the trouble developed from the cross-connecting of the armature leads, probably at the brush-holder studs when the machine was reassembled after repairs, an error easily made on many machines. An analysis of the situation revealed that there were four elements only that had a bearing on results. These are stated as follows: (1) The cross-connections of the armature leads; (2) the excitation of the field from a separate circuit; (3) the restoration of armature leads to their proper position; (4) the final flashing of the field with the battery.

Fig. 1 shows the connection of the generators as they should be. Suppose, then, that the armature leads are reversed at the terminal board, as in Fig. 2; this reverses the direction of the current through the series- and shunt-field windings. The reverse current tends to set up a magnetic flux in opposition to the residual magnetism of the polepieces, which creates a balanced condition between the two, consequently the generator cannot build up. Flashing the shunt field from an outside source will not help matters any, even though the residual magnetism of the polepiece is reversed, since this would reverse the polarity of the generator, consequently the current through the field windings, which is a condition similar to that in Fig. 2.

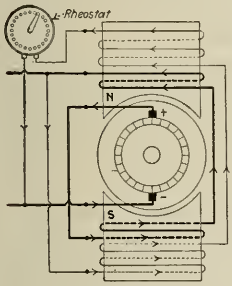


FIG. 1. GENERATOR CONNECTIONS MADE CORRECTLY

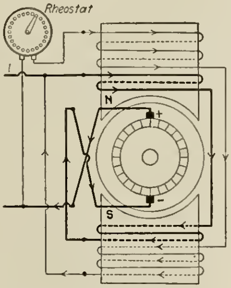


FIG. 2. GENERATOR WITH ARMATURE CONNECTIONS CROSSED

There are probably two reasons for the generator building up to only approximately half voltage when excited from the 210-volt circuit: First, the exciting voltage was lower than the normal voltage of the generator, and second, the field rheostat was probably all cut into the shunt-field circuit, a condition that could have been brought about easily by someone turning the rheostat in an effort to get the generator up to voltage.

When the armature leads were reversed, this brought about the right condition, as shown in Fig. 1, but the polarity of the polepiece had been reversed when the field coils were excited from an outside source, consequently the generator built up the wrong polarity. Of course this was easily changed by sending a current through the field coils in the opposite direction. It will be noted that if the connections of the generator are correct to build up one polarity, the machine will also build up the opposite polarity, it being only a matter of what polarity the residual magnetism has in the polepieces.

O. B. CRITCHLOW.

New Brighton, Penn.

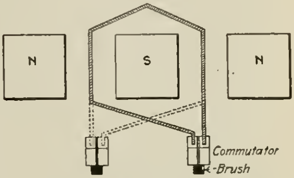


FIG. 3. TWO POSITIONS OF ARMATURE COIL LEADS

I have seen cases like that described by Mr. Tomlinson. The machine probably has the brush studs in line with the space between the field poles, and the armature winder made a mistake and connected the leads the wrong way, as shown in Fig. 3. The full lines show one possible position and the dotted lines the other position. If the full-line connections would make the right-hand brush positive, the dotted connections would make the left-hand position positive.

A generator will not build up if the relation between the armature and field connections is wrong, no matter what polarity the residual magnetism may have; any voltage generated by the residual magnetism will set up a current in the field winding in such a direction as to oppose and tend to destroy the residual magnetic field.

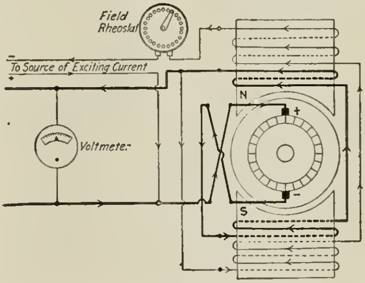


FIG. 4. SHUNT-FIELD WINDINGS EXCITED FROM OUTSIDE SOURCE

When the machine was separately excited, the low voltage may have been due to a load on the machine and the load current was flowing in the reverse direction to the series field, its effect being in opposition to that of the shunt field. This opposition would have existed no matter which way the current was sent through the shunt field. Now, when the armature leads were crossed, everything was made right and the relation between the armature and field is now correct, and the machine will build up no matter which way the residual magnetism may be. If the voltmeter shows a reverse voltage, a change of residual magnetism will correct this.

Albert E. Carpenter.

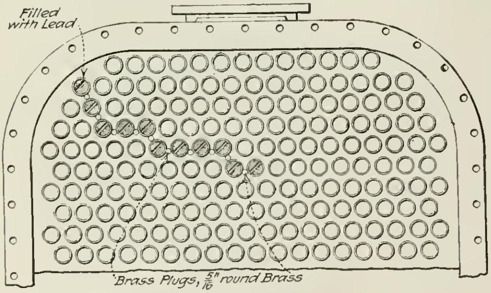
Adams, Mass.

[In a number of discussions submitted on the difficulty experienced by Mr. Tomlinson in getting the generators to build up, a great deal of stress was laid on the series and shunt-field windings being in opposition. However, it is evident from Figs. 1 and 2 in Mr. Critchlow's discussion, since the difficulty was remedied by crossing the armature lead, that the field windings were not connected in opposition. Furthermore, if the series and shunt windings were connected in opposition, the effect of the series winding would be practically negligible until a load was put on the machine. The probable cause for having to cross the armature lead is accounted for in Mr. Carpenter's discussion. However, why the machines only generated about 110 volts with the shunt-field coils excited from a 210-volt circuit is very likely due to connecting the exciting circuit as in Fig. 4. If a connection is made to an external source of exciting current, as in the figure, with the armature leads connected so that the machine cannot excite its own field, the voltage generated in the armature will oppose that applied to the field coils and the machine will generate only approximately 50 per cent. of its normal voltage. With the armature and field windings connected in their correct relation, connecting the machine to an outside excitation source, as in the figure, will generate a voltage in the armature of the same polarity as the exciting current. This is made evident by crossing the armature lead in the figure. The result of this connection is to increase the voltage above normal about 25 per cent. However, the increase is determined by the saturation of the magnetic circuit.—Editor.]

Plugged Cracked Condenser Tube Sheet

The accompanying sketch shows how I repaired a cracked tube sheet of a surface condenser. I removed the tubes following the crack and used the ferrules as plugs, first filling them with lead. After screwing them in solid, I drilled and tapped into the crack between the plugs for $\frac{5}{16}$-in. plugs, which filled up the space between the ferrule holes. After dressing with a calking tool, I had no trouble. Thomas Mulligan.

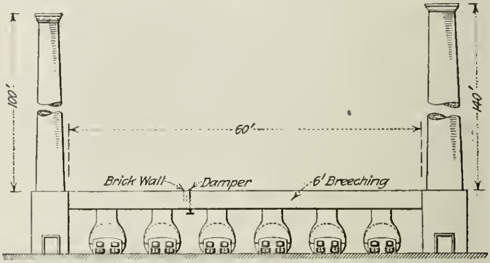
Woodside, N. Y.



CRACK IN CONDENSER HEAD MADE TIGHT WITH PLUGS

Chimney Had Back Draft

The owners of a large distillery in Kentucky recently sold their plant to a newly organized manufacturing concern. When the officials of the new company attempted to try out the plant, they were unable to get satisfactory results. The boiler equipment consisted of six Scotch marine boilers, five of 250 hp. and one of 300 hp., all with the dutch-oven type of furnace. The trouble seemed to be a lack of sufficient draft, and in the hard firing used in the attempt to get results from the boilers the front fire-doors had been warped by the heat. In boilers Nos. 1, 2 and 3 it was practically impossible to get a hot fire, the coal charging and smoldering in a dead mass.



SMOKE CONNECTIONS TO CHIMNEYS, BRICK WALL AND DAMPER

Having been sent to investigate and, if possible, remedy the trouble, I found the following peculiar condition: There were two stacks, one 100 ft. high, 5 ft. in diameter, the other 140 ft. high, 6 ft. in diameter. These stacks were connected by a cylindrical breeching about 60 ft. in length and 6 ft. in diameter, to which the uptakes of the boilers were connected.

There was a cutoff damper between boilers Nos. 2 and 3, but by getting inside the breeching I found that it was impossible to close this damper by hand, and a heavy current of air was flowing constantly from the smaller to the larger of the stacks. With six men and a battering ram I managed to close the damper; then I had a solid brick wall built at a distance of two inches from the damper inside the breeching, at the same time packing the space with asbestos cement. This gave a practically air-tight wall, separating the breaching into two independent sections and isolating the stacks. It was then found by testing that the separated stacks gave sufficient draft for the connected boilers and it was possible to operate at a high rating without trouble.

Before the change was made, it was impossible to get higher than 4 per cent. CO_2 on any of the boilers, and it was necessary to build a large fire in the base of the smaller stack to get enough draft to maintain fires in boilers Nos. 1, 2 and 3. After putting in the wall the boilers were operated at from 12 to 14 per cent. CO_2 and without the use of fires in the base of stacks to aid the draft.

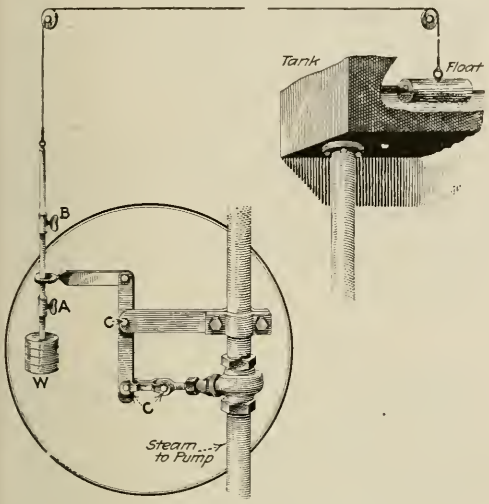
Of course the trouble was due to the taller stack of larger diameter having a stronger draft, which caused a down-draft in the smaller stack, and as the breeching was filled with air from this source there was very little draft available at the furnaces. Edwin L. White.

Louisville, Ky.

Float Control for Pump

The illustration shows a tank-pump float control that is about as simple as cou'd be put together. The float is a log heavy enough to overbalance the rod, weight and connecting line. The limits *A* and *B* can be set so that the pump will not begin working until the tank is nearly empty and will stop when the tank is full or at any other point desired. **James E. Noble.**

Portsmouth, Ont., Canada.



DETAIL OF VALVE GEAR

Water-Column Blowoff Valves

On page 499 of the Apr. 1 issue of *Power* is a communication regarding water-column valves, which should be carefully studied before using water-column blowoff or drain valves of the globe type, as Mr. Pascoe recommends.

I do not approve of angle or globe valves being used on either the drain pipe from the water glass or in the water-column connections. The pocket beneath the seat forms a space for the collection of scale and mud and will plug up frequently unless blown out at regular intervals. With the pressure beneath the disk the valve will always open if the pipe is not choked up, somewhat as a check valve is opened.

Globe valves with composition disks are likely to rapidly cut away on the disks and seats and require frequent renewals and regrinding. Otherwise, with rough seats the disks will continue to leak and wear out rapidly. The proper way to connect a globe valve is to have the pressure beneath the disk, as the disk area is small and it is easily held to its seat by the pressure of the steam screw, therefore there is less strain on the bonnet than if the pressure came out on the other side of the disk. The valve stem can also be packed at any time. Where globe valves are used, I believe that it is advisable to use a valve with a brass disk.

A globe valve connected with the pressure on top of the disk is in my opinion dangerous. In one instance a valve so placed began to leak. Then the attendant applied a wrench on the wheel to screw it up tighter, and the bonnet was forced off. The reason was that the inside area of the bonnet was exposed to full boiler pressure, and this area being much greater than that of the under side of the disk, carried many times more pressure than would have been carried by the small portion of the disk that would have been under boiler pressure if the pressure had been under the disk. Adding the boiler pressure to that developed by screwing up the stem as tight as possible was more than the valve was capable of withstanding.

The pocket back of the disk will plug up with scale and mud, and the valve stem cannot well be packed while steam is on the boiler. The seats and disks will cut away, and the reason they don't start to leak sooner is because the steam pressure on a large area of the back of the disk holds it tightly to the seat, but when once started it is even worse than if the pressure were beneath the disk.

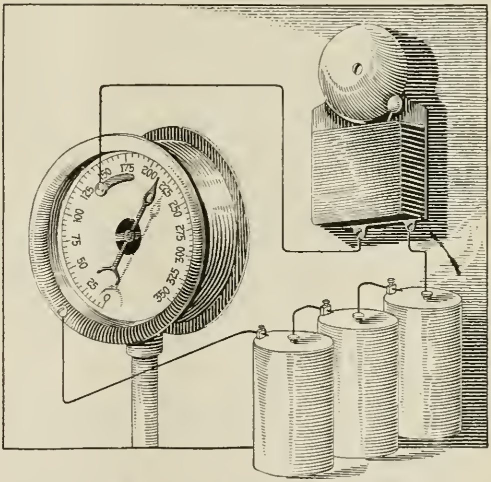
License and boiler laws of some states prohibit globe valves on water-column drain pipes, only gate or straightway valves being permited. **R. A. Cultra.**

Cambridge, Mass.

Hydraulic Pressure-Gage Alarm

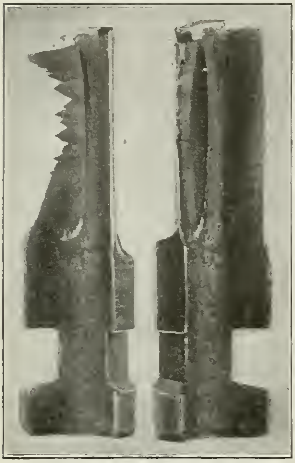
A pressure alarm attached to a hydraulic gage in a certain plant was made by drilling a small hole in the glass face of the gage in line with the travel of the pointer, through which an electric terminal was attached, as shown in the illustration. The other terminal was connected to the body of the gage. The bell can be set to ring at any pressure by adjusting the glass face of the gage. In this plant it is set at 175 lb. When the pressure drops to this point, the pointer completes the circuit and the bell rings, giving the alarm to the engineers in charge, who get into quick action to find the cause of the low pressure, as the plant will not operate very long at 175 lb. It requires 210 lb. to keep it in operation. **J. A. Landolina.**

Memphis, Tenn.



ARRANGEMENT OF CONTACTS ON PRESSURE GAGE

Peculiar Erosion of Turbine Bucket



EROSION OF TURBINE BUCKET

The illustration shows two views of a bucket taken from the first wheel of the second stage of a 1500-kw. Curtis turbine that had been in service five years. The edge of the bucket is worn away in the saw-tooth manner shown at the left and a deep groove is formed lengthwise of the bucket at about the middle of its width, as shown at the right. The erosion is so peculiar that I thought it would interest readers of *Power*. The other buckets in the same wheel were eroded in this same manner. The buckets in the other wheels, however, showed uniform wear, without the deep grooving. E. W. York.

Oil City, Penn.

Efficiency in a Paper Coating Mill

I have been intensely interested in power-plant economy for the last twelve years and have had the pleasure of making reductions in the cost of power in several plants. The maximum savings realized varied from 22 to 35 per cent., based on the cost per kilowatt-hour. These savings were difficult to obtain and required hard work for long periods of time; however, I have recently been able to make the biggest showing in a short period in a plant where it was not even suspected that any reduction could be made in power costs.

Expenses have not been reduced in the power plant, but the hourly capacity of the mill has been increased over 70 per cent. through improving the drying of the paper after coating. As the coating must be sufficiently dried so that it will not stick when it comes in contact with the guide rollers, and especially the apron, it is obvious that the quantity of paper turned out depends upon the drying efficiency.

One would naturally suppose that all that is required is very hot air, but I have discovered that this is not the chief essential. The drying depends in great part upon the humidity of the air; hence it was largely through making a study of this condition that the mill capacity was increased as mentioned. The weight of paper per pound of coal manufactured was increased from 0.6 lb. to 1.03 lb. approximately. In addition to this we have good reason to believe that we will be able to increase the paper output per pound of coal to 1.5 lb., or, say, 50 per cent. This has already been achieved under ideal conditions.

I would be very glad to tell the readers of *Power* just how the drying was done. However, it would be of little interest to those who do not understand the paper-mill game, so I merely offer this as a suggestion that the employers invite their chief engineers to coöperate with them in the manufacturing processes, also that engineers make a study of these processes with a view of preventing penny-wise and pound-foolish economy methods in the power plant.

What the manager or mill owner most desires is a good product and an attractive profit. Hence it is of special importance to the engineer that he guard against adopting such economic policies as may interfere with the manufacturing processes, with the results that the production be lowered both as to quality and quantity, which in turn results in less profit to the owner.

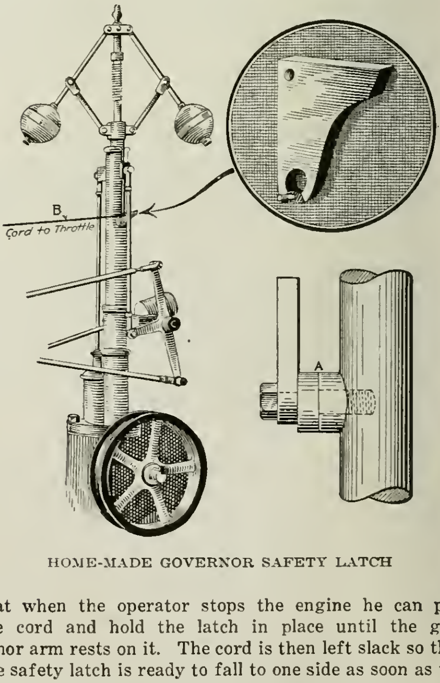
Of course it is essential that the engineer be in a receptive mood and that he display the attitude of being willing to help and not get on the wrong track in thinking that he is the only one who knows anything about it. It should be remembered that chief executives never like such an attitude. Waldo Weaver.

Franklin, Ohio.

Governor Safety Latch

A governor safety latch that has been used on several engines in my plant for about five years is shown in the illustration. It is always ready when applied properly, and there is nothing to get out of order. The latch is cut from a piece of quarter-inch iron plate. The collar *A* is made to fit the governor stand, which in my case is four inches in diameter. The cord *B* extends from the hole in the top of the latch to the throttle so that when the operator stops the engine he can pull the cord and hold the latch in place until the governor arm rests on it. The cord is then left slack so that the safety latch is ready to fall to one side as soon as the engine is stalled and the governor lifts enough to free it. A pin prevents the latch from falling too far in either direction. H. H. Finch.

Springfield, Mo.



HOME-MADE GOVERNOR SAFETY LATCH

Inquiries of General Interest

Advantages of Inertia Governors—What are the advantages of inertia governors over simple centrifugal shaft governors? C. B.

Inertia governors act quicker in adapting the point of cutoff to a change of load and are capable of a design in which the inertia and centrifugal effects are so combined that, for a change of load, the speed of the engine is held closer to the normal speed than when only centrifugal effect is depended upon.

Current Density for Electroplating—What current densities in amperes are used for electroplating? W. L. A.

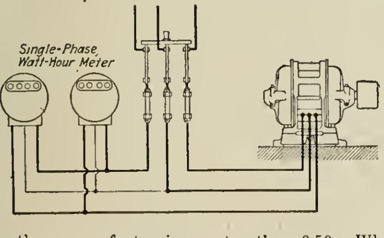
The usual densities employed for different metals are:

Copper, cyanide bath	3 to 5	amperes per sq. ft.
Copper, acid bath	5 " 10	" " " "
Nickel, double sulphate,	6 " 8	" " " "
Gold, Chloride in cyanide,	1 " 2	" " " "
Silver, double cyanide,	2 " 5	" " " "

Low current density produces a hard close grained surface and a high current density gives a softer, more open deposit which may present a powdery appearance.

Metering Three-Phase Power—I have a 75-hp. 220-volt three-phase 60-cycle motor and wish to install integrating wattmeters. As the meters on hand were rated at only 150 amperes, I put two of them in parallel on one phase, as shown in the figure. With this connection the meters ran very slowly when the motor was loaded; when the load was light the meters ran backward. What caused this action of the meters? C. S. H.

The action of the meters was due to their being connected in the low-reading side of the circuit. If a watt-hour meter is connected first in one phase of a three-phase circuit and then in another phase, it will be found that the readings will not be alike unless the load is balanced and the power factor 100 per cent. When the power factor is less than 100 per cent., even if the load is balanced, as it generally is in the case of an induction motor, the meter will read higher on one phase than it does on the other as long as the power factor is greater than 0.50. When the power factor is less than 0.50, if the meter is connected to one phase it will read fast and will reverse when connected to the opposite phase. This is what happened as the meters were connected in on the low reading phase. When the motor was loaded, the power factor was above 0.50 and the meters registered slowly in the proper direction, but when the load was removed from the motor the power factor dropped below 0.50 and the meters reversed and ran in the opposite direction, as they should. If the meters had been connected into the opposite phase, they would have run fast and indicated an excess load on the motor. The only way that three-phase power can be metered satisfactorily is with two single-phase meters connected into two of the phases, or with a polyphase meter, which is practically nothing more than two single-phase meters combined in one instrument.

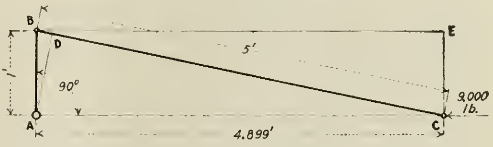


Effect of Moisture on Engine Economy—What effect has moisture of steam on economy of an engine? An engine that is guaranteed to develop a horsepower-hour on 28 lb. of dry steam is found to require 30.8 lb. of steam containing 5½ per cent. of moisture. What per cent. is the performance above or below the guarantee? R. N. L.

Experiments on engine economies, using steam of various percentages of dryness, seem to confirm the fact that the ill effect of moisture is proportional to the percentage of moisture present; that is, the consumption of dry steam remains practically constant. Accordingly, a consumption of 30.8 lb. of steam containing 5½ per cent. moisture would be equivalent to consumption of $30.8 \times (1 - 0.055) = 29.1$ lb. of dry steam, and if 28 lb. of dry steam was guaranteed, it is fair to assume that the steam consumption is $(29.1 - 28) \div 28 = 0.039$ or practically 4 per cent. greater than guaranteed.

Pressure on Crankpin and Guide—An engine crankshaft that is 1 ft. long is placed at right angles to the line of the engine and blocked there. The length of the connecting-rod is 5 ft. and there is a force of 9000 lb. acting on the piston. Neglecting friction, what is the pressure on the crankpin and what is the downward pressure on the guide? J. V. M.

Referring to the diagram, if *AC* is the engine center line, *AB* the crank 1 ft. long at right angles with *AC*, and *BC* the connecting-rod 5 ft. long, then for the given position of the crank the side *AC* of the right-angled triangle *ABC* would be equal to $\sqrt{5^2 - 1} = 4.899$ ft. From *A* draw *AD* perpendicular to *BC*. In the right-angled triangle *ADC*, if *AC* by its direction and length is taken to represent the force of 9000 lb. acting from *C* toward *A*, then *DC* will represent the direction of pressure exerted on the crankpin due to the thrust of the connecting-rod from *C* toward *D*, and to the same scale that the length of the side *AC* is taken to represent the pressure 9000 lb. acting along the center line of the engine. As the right-angled triangles *ABC* and *ADC* are similar, $DC : AC :: AC : BC$, or as $4.899 : 5$, and therefore the pressure on the crankpin, represented by DC, is $\frac{4.899}{5}$ of 9000 lb. = 8818.2 lb.



To find the pressure down on the guide, suppose *BC* to represent the direction and magnitude (8818.2 lb.) of thrust of the connecting-rod. This force, acting from *C to B*, can be resolved into two others at right angles to each other; namely, *EC* perpendicular to *AC* representing the direction of pressure exerted on the guide, and *BE* the force exerted by the thrust in the direction parallel to *AC*. The triangle *BEC* is equal to the triangle *ABC* and $EC = AB = 1$. As the thrust of the connecting-rod, amounting to 8818.2 lb., is represented to the same scale by $BC = 5$, then *EC*, which represents the pressure on the guide, has a value of one-fifth of 8818.2 lb. = 1763.6 lb.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Economy of Arizona Power Plants Using Oil Fuel*

By C. R. WEYMOUTH
Chief Engineer, Charles C. Moore & Co., San Francisco, Calif.

Treats of the performances of three steam-electric power plants in Arizona where load factor and high fuel cost demand economical operation. Tables and curves of operating characteristics are given and some of the difficulties encountered in practice are enumerated.

IN certain Arizona steam power plants the combination of favorable load factor and high fuel cost has not only necessitated but has also made possible the attainment of high fuel economy, and even in plants where cooling ponds are used for condensing purposes. This paper refers to the performance of three such power plants; namely, those of the Inspiration Consolidated Copper Company, Inspiration, Ariz.; the New Cornelia Copper Company, Ajo, Ariz.; and the Arizona Power Company, Clarkdale, Ariz. These plants embody many similar features. They differ, however, in methods of condensing as cooling ponds are used at the Inspiration and New Cornelia plants, and water from the Verde River at the Arizona Power Company's plant.

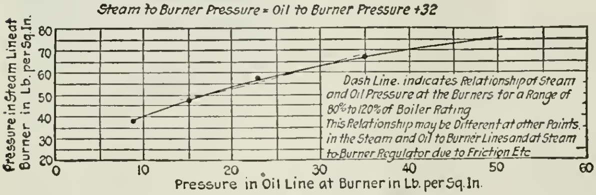


FIG. 1 STEAM AND OIL PRESSURES AT BURNER LINES

The Inspiration plant was designed in the winter of 1913-14. The International Smelting and Refining Co.'s smelter adjoins the Inspiration power-plant site, and the steam generated in waste-heat boilers in the smelters is utilized for the operation of the reciprocating blowing engines, which are designed for about 175 lb. steam pressure. These blowing engines are located in the same power-plant building as the steam turbines, and since the waste-heat boilers are connected to the same steam header as the oil-fired boilers, their steam pressure and the economy of the turbine plant have been limited by the common steam pressure of from 175 to 185 lb. The New Cornelia Copper Co.'s plant was designed in the winter of 1915-16, and being independent of blowing engines, the boilers were selected for 250 lb. pressure. While a higher steam pressure would have been possible, the remote location of the plant and experience at the date of design led to the lower boiler pressure being selected. The Arizona Power Co.'s plant was designed in the winter of 1916-17, and has boilers for 250 lb. pressure.

The Inspiration plant is 25-cycle, 3-phase, 6500 volts. The New Cornelia plant and the Arizona Power Co.'s plant are both 60-cycle, 3-phase, 2300 volts. The maximum load at the Inspiration plant was estimated to be 12,000 kw.; three 6000-kw. Curtis turbines were therefore selected, thus giving one spare turbine. For the New Cornelia plant the load was estimated to be 7500 kw., and this led to the selection of two 7500-kw. turbines, one unit being a spare. The Arizona Power Co.'s plant was designed as an auxiliary to a hydro-electric system, and intended to carry a peak load of 5000 kw. Owing to the quick shipment required, however, a turbine previously ordered for another company, and rated at 6000 kw., was installed, whereas the remaining equipment was selected for a 5000-kw. load.

All three plants have Stirling steel-encased boilers, with Peabody-Hammel oil furnaces, Green fuel economizers, Moore automatic fuel-oil regulating systems, Wheeler surface condensers, Wheeler dry vacuum pumps, centrifugal hotwell pumps, direct-connected exciters, steam-driven boiler-feed pumps, etc. Superheaters are installed in all plants, specified to give 100 deg. superheat for the Inspiration plant, and 150 deg. superheat for both the New Cornelia and the Arizona Power Company's plants, all measured at the boiler, and at normal rated capacity of the boilers. All the plants also have centrifugal circulating pumps, the Inspiration pumps being turbine-driven, and the others motor-driven.

The nozzles for the cooling pond of the Inspiration Copper Company's plant were furnished by one of the spray pond companies, who also proportioned and designed the pond arrangement. The actual vacuum shown by the operation of this plant, however, has been a disappointment, as a pond of insufficient area was installed. Since the design of the Inspiration plant this detail has been corrected by the addition of cooling towers. The condensate is returned to the oil-fired boilers, and make-up water for the pond is purified by a Booth water softener. A Cochrane hot-process purifier purifies the make-up for the oil-fired boilers if needed, but it is primarily for purifying boiler feed for the waste-heat boilers installed at the smelter. The blowing engines operate at slightly lower vacuum than the turbines, and advantage is taken of this fact to heat slightly the turbine condensate by passing it through the Volz heaters in the surface condensers or the blowing engines.

Cole-Bergman water weighers and Lea recorders are installed for feed-water measurements, for computing the steam supplied from the waste-heat boilers and the steam required by blowing engines, as well as the steam consumption of the turbines. Steam-flow meters are also used for checking purposes. By this means a separate record is kept of the economy of the turbine plant on the basis of operation independent of the blowing engines.

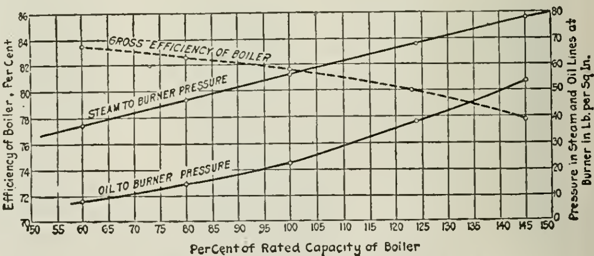


FIG. 2. PRESSURES AND EFFICIENCIES AT VARIOUS LOADS

The feed water for the New Cornelia plant contains from 30 to 50 grains of impurities per U. S. gallon. The water is low in calcium sulphate and carbonate, high in sodium sulphate, and very high in sodium chloride. It is not practicable to purify this water by chemical treatment. The condensate from the condensers is returned to the boilers, and raw make-up water is used for the pond and boiler-feed make-up purposes. Frequent blowing down is required for the cooling pond, as well as for the boilers. Scale is also formed both in the condensers and the boilers, and this requires frequent cleaning, as condenser scale tends to impair the vacuum.

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*Presented at the Spring Meeting, Detroit, Mich., of The American Society of Mechanical Engineers.

The Arizona Power Co. uses Verde River water for condensing purposes, this being taken through a flume at such a point that the pumping head is reduced by gravity flow. The condensate is returned to the boilers, and the raw make-up water is purified in a Cochrane hot-process purifier.

Economy of Inspiration Consolidated Copper Company Plant—Upon the completion of the Inspiration plant it was placed in regular service. The performance of the individual pieces of apparatus was investigated in order to make certain that everything was working to the best advantage, particular attention being paid to the efficiency of boilers, the adjustment of burners, furnaces, and the automatic firing system. A number of uniform load tests were made of boilers for checking purposes, and the results obtained are given in the curves of Figs. 1 and 2. These tests show a fairly high efficiency at rating, and, rather contrary to the usual results obtained with noncasing boilers, a higher efficiency at fractional loads than at rating. The higher efficiency is due to the tightness and the insulating efficiency of the steel casing. As a result of these tests, instructions were given the operators to divide the load equally among all boilers and this, of course, was done automatically by the firing systems. The operators, however, were instructed to keep as many boilers on the line at light loads as could be properly fired, maintaining a fire in each of the three burners per boiler; below this load boilers were cut off the line, and only refired when the load again increased.

The curves of Figs. 1 and 2 show the relation between the steam pressure of the atomizing steam and the oil pressure, both measured in the supply pipes at the individual burner, between the throttle valve and burner. From data obtained from these curves, the steam-to-burner regulator was set to give the proper pressure of atomizing steam, based on the momentary oil pressure.

Under variable load the damper controller has been able to maintain CO_2 readings varying from 12 per cent to 14.5 per cent CO_2 for which the corresponding excess air for normal conditions is 28 per cent and 6 per cent, respectively. After instructing the operators, and while the plant was still under the control of the engineers, an average economy was obtained for the month of September, 1915, as given in the following table:

Average number of turbine units in operation.......	1
Average daily load, 24-hr. basis, kw..................	5,980
Average steam pressure at boilers, lb. per sq in	178
Average vacuum in condensers, in. of mercury, absolute..................................	2.66
Average rating of boilers, per cent..................	95
Gross boiler efficiency, per cent....................	80.9
Average economy, kw.-hr. per bbl. of oil as fired.....	281
Average economy B.t.u. per kw.-hr..................	25,900

In the subsequent operation of this plant by the owners the economy has been maintained practically equal to that shown under the direction of the engineers, but during the winter, due to colder circulating water, the economy is even better than indicated above. On the other hand, during the summer months, with the warmer circulating water and falling off in vacuum, the economy naturally drops to a lower figure than that given for the month of September.

This plant operates in conjunction with the hydroelectric plant at the Roosevelt Dam, and at periods of the year preference is given to hydroelectric power. As a result, there is a fractional load, or partial shutdown of the steam plant, and for certain months this in turn has naturally resulted in a reduced economy.

The operating results for the plant, furnished by W. W. Jourdin, chief engineer of the Inspiration power plant, are given by the curves of Fig. 3. It will be noted that the best monthly economy for winter conditions has been 294.5 kw.-hr. per bbl. of oil, or 20,910 B.t.u. per kw.-hr.; and the poorest economy for summer conditions for the normal load has been 257.5 kw.-hr. per bbl. of oil, or 23,700 B.t.u. per kw.-hr., although for the month of September, 1917, due to the very light load, the economy was only 237 kw.-hr. per bbl. or 25,970 B.t.u. per kw.-hr. As previously stated, this plant, in comparison with non-cooling-pond plants, is subject to an accumulation of scale in the condensers, and as a result there is a slight loss in vacuum. Since purified feedwater is used, the plant is not subject to troubles from scale formation in the oil-fired boilers, nor does any loss of fuel result from shutting down boilers for cleaning or boiler blowoff.

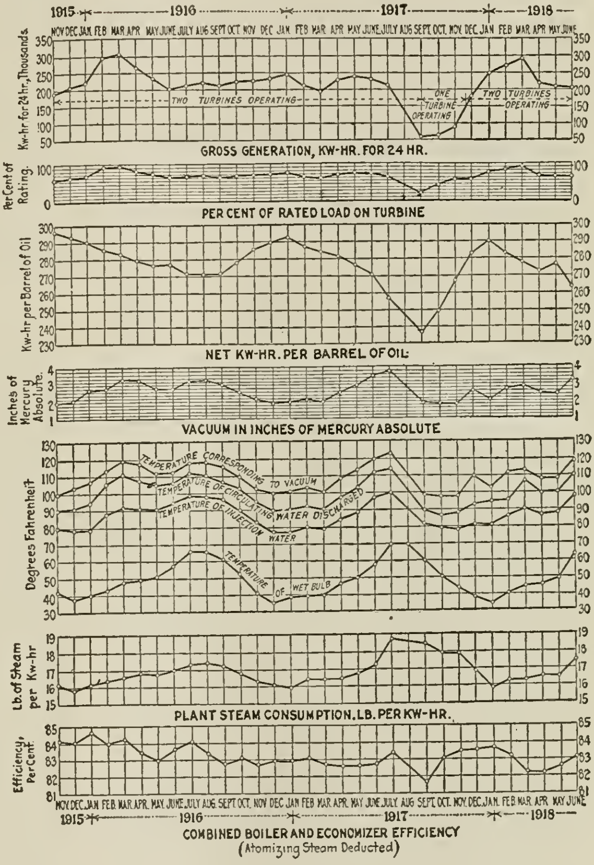

FIG. 3 OPERATING CHARACTERISTICS OF THE INSPIRATION POWER PLANT

The curves of Fig. 3 give the operating records for combined boiler and economizer efficiency, atomizing steam deducted; this being the form in which the power-plant records are kept. A comparison of this result with the boiler efficiency tests would seem inconsistent without the explanation that the economizers at this plant heat the feed water through a temperature range of from 40 deg. to 45 deg., whereas it will be noted that results for the Arizona Power Company's economizers, given in the table indicate a temperature rise in the economizer of 91 deg. F. In proportioning the Inspiration economizers with reference to the investment and fuel saving, it was assumed that the average period of operation would be less than half the year, owing to the use of hydroelectric power; it was also assumed that the fixed charges would be very high. This combination of circumstances, together with high freight rates and construction costs in Arizona, resulted in the selection of an economizer of comparatively small surface, giving a favorable return on the investment but a result considerably less favorable than that attained in the average economizer with oil fuel, when measured only by temperature rise.

Economy of the New Cornelia Copper Company Plant—Following the installation of the New Cornelia plant in November, 1917, an attempt was made by the designing engineers to check the economy of the station, but owing to the war and a scarcity of labor this work had to be abandoned before completion.

This plant, due to its location in the southwestern portion of Arizona, is subject to more intense summer heat than probably any other power plant in the western territory, and this in turn gives rise to considerably less favorable cooling-pond and condenser performance, with respect to vacuum, for the summer months than for the winter months. The vacuum performance is also influenced by the accumlation of scale within the condensers between the periods of cleaning condensers, due to concentration of salts in the cooling pond.

The best economy for this station known to the writer is for the month of January, 1918, the average performance for four successive days being about 324 kw.-hr. per bbl. of oil, as follows:

Date 1918	Average Load, Kw.	Economy, Kw.-hr. per Bbl. of Oil	B.t.u. per Kw.-hr.
January 26	7921	321.7	18,975
January 27	7830	324.1	18,833
January 28	7725	324.2	18,829
January 29	7800	326.2	18,711

The poorest economy for this station during the summer of 1917, was for the month of July, namely, 293.5 kw.-hr. per bbl. The average vacuum was 1.66 in. absolute and the average load 5550 kw. The poorest economy during the summer of 1918 was also for the month of July, or 287.5 kw.-hr. per bbl. The average vacuum was 2.14 in. abs., the average load 5850 kw., and consequently the economy for the summer of 1918 was abnormally low.

The monthly report for December 1918 gives the following: Average load, 7800 kw.; average economy, 312 kw. per bbl. and 19,913 B.t.u. per kw.-hr. The monthly report for January 1919 gives: average load, 7790 kw.; average economy, 317.9 kw. per bbl., and 19,535 B.t.u. per kw.-hr. The improvement for the month of January over December is due to a straightening out of the aforementioned difficulties experienced in the summer of 1918, and it is the writer's belief that the station will soon be operating at its best previous economy for the corresponding season.

It will be noted that the economy of the New Cornelia plant is materially better than that of the Inspiration. This is due somewhat to the larger turbine units installed, but in the main to the higher steam pressure and to the improved design of cooling pond, which results in better vacuum. In comparing the economy of these cooling-pond stations with that obtained in tidewater plants, allowance should be made for the size of turbine units, the obtainable vacua under operating conditions, the increased head on circulating pump due to the greater quantity of water which must be handled through the condensers, and the increased pumping head due to the cooling-pond nozzles and longer lengths of circulating-water line.

Economy of the Arizona Power Company's Plant—This plant was completed in September, 1917, and due to the war conditions in the mining region it was difficult to assemble a skilled operating crew. The plant was furnished under a contract covering a complete plant-economy guarantee at 5000-kw. load, and the final test, covering 48 hours' operation in regular commercial service, under variable load, was concerned mostly with the economy at this load, although a run was made at 6000-kw. load, which is the rated capacity of the turbine. The results for the final test are here given in the table. At all times during this test the plant was subject to a variable load, due to the regulation of the hydroelectric system. The oil was carefully weighed and the electrical output was measured by calibrated meters. The electrical output given is the net useful output for the station at the 2300-volt bus, deduction having been made for the power consumption of electric auxiliaries, including lighting for the operators' cottages, circulating water pump, deep-well pump and air washer. The average electrical auxiliary load was 46 kw., which is somewhat smaller than would have been the case had the entire head on the circulating water been overcome by pumping; against this condition is the fact that during the test the quantity of circulating water was somewhat less than specified, so that, roughly speaking, the one condition nearly offsets the other.

It is not possible to give daily operating results for this plant, at the load for which it was designed, for since its installation it has been maintained only for reserve purposes, carrying occasional peaks but most of the time a very light load, and for a number of hours during an average day with the turbine at standstill. Of course favorable economy is not possible under such conditions, as the fuel losses due to keeping hot boilers, piping, etc., the dead-load losses for the operation of auxiliaries, and the zero-load steam consumption of turbine result in a zero-load fuel consumption of the plant which is an appreciable percentage of the full-load fuel consumption.

It is of interest to note that the turbine at the Arizona Power Company's plant is practically a duplicate of those at the Inspiration Copper Company's plant, having the same number of stages; the difference in the operating economy of the turbines being largely due to steam pressure. Here again is a marked increase in plant economy due to an increase in steam pressure, and also by reason of the colder river water at the Arizona Power Co.'s plant as compared with the cooling-pond water at the Inspiration plant and the consequent improvement in vacuum. All economy figures are based on oil as fired, without deduction or correction for moisture, sulphur, or silt.

RESULTS OF TEST OF THE ARIZONA POWER COMPANY'S STEAM PLANT AT TAPCO, ARIZ.

Duration of test, hours	6
Boiler pressure, lb. per aq.in., gage	250
Steam pressure at turbine throttle, lb. per sq.in., gage	238.5
Avg. temp. of superheated steam at boilers, deg. fahr	546
Temp. of superheated steam at turbine, deg. fahr	516
Temp. of feedwater entering boilers, deg. fahr	207
Temp. of water leaving feedwater heater, deg. fahr	116
Temp. of circulating water from condenser, deg. fahr	62.4
Temp. of circulating water to condenser, deg. fahr	45.7
Room temperature, deg. fahr	83.2
Barometer, inches of mercury	26 773
Vacuum in condenser, inches of mercury	25 783
Absolute vacuum, inches of mercury	0.990
Temp. of flue gases leaving economizer No. 3, deg. fahr	276
Average load, kw. per hr	5,815
Power factor by power-plant indicator	0.93
Electrical Output by Integrating Meters:	
Gross kw. generated	34,890
Gross kw.-hr	5,815
Auxiliary power, kw	277
Net kw. output	34,613
Net kw.-hr. output	5,769
Oil Measurements:	
Total oil weighed, lb	34,516
Correction due to diff. in temp. at start and finish, lb	46
Oil actually used, lb	34,470
Average gravity of oil (analyzed by Smith, Emery & Co.), deg. B.	17.65
Weight of oil per bbl. of 42 gal	332
Heat value of oil (analyzed by Smith, Emery & Co.), B.t.u. per lb.	18,703
Economy:	
Fuel used per gross kw.-hr., lb	0.988
Fuel used per net kw.-hr., lb	0.996
Kw.-hr. per bbl. of oil, gross	336.0
Kw.-hr. per bbl. of oil net	333.3
B.t.u. per kw.-hr., gross	18,478
B.t.u. per kw.-hr. net	18,628

Petroleum Institute

The establishment of a petroleum institute for this country with headquarters in Washington is urged and contemplated by many of the leading petroleum refiners. The rapidly diminishing stocks of petroleum oils in this country have been causing much concern among oil refiners, and problems growing out of the increasing demands for oil products promise to assume alarming proportions in the next few years. The proposed institute will afford a means of coöperation between the Government and all the branches of the oil industry.

Mechanical Engineers Hold Spring Meeting in Detroit

FOR the four days from June 16 to 19 inclusive, in the ideal convention city, Detroit, the American Society of Mechanical Engineers held one of the most profitable and enjoyable meetings in the history of the organization. The attendance was the largest on record for a spring meeting. Topics of foremost importance to the profession were up for consideration. The report of the Committee on Aims and Organization was representative of the progressive thought of the day and gave promise of remarkable engineering advancement. There was a session on research considered the key to industrial progress, discussion of industrial relations under present conditions and sessions on fuel economy and furnace efficiency, gas power and other topics of engineering interest. All was not work, however, as professional sessions alternated with inspection trips to the numerous industrial plants that have made Detroit world famous. Then there was entertainment. No city in the country has more or better facilities on land and water or hospitality to use them to the fullest extent in the entertainment of guests, than Detroit. The local committee is to be congratulated as it was the consensus of opinion that the arrangements for an enjoyable time, renewal of acquaintances and interchange of ideas were perfect.

Monday Morning and Afternoon Sessions

Monday morning was devoted to the opening of headquarters and registration at Hotel Statler. In the afternoon there was a business meeting with President Cooly in the chair, to hear read by title the reports of the Boiler Code Committee on rules for the construction of boilers for locomotives, the reports of subcommittees on flow meters, bearing metals and lubrication and the epoch-making report of the Committee on Aims and Organization. The report was given as a cross-section of the opinion of the membership gathered from the questionnaires that had been sent out. The committee considered it a constructive program expressed in broad principles to meet the real problems with which the society is now confronted. The report was not considered complete, as the committee is to meet with a joint committee of the four founder societies to give it further consideration. An expression of opinion from the convention as a guide to the council and the committee was requested, and the various resolutions were passed upon singly or in groups.

Among these resolutions it was the sense of the meeting that the society should stand back of professional reports and standards by adopting them rather than pursuing the present passive policy of accepting the reports. It was suggested that such procedure would necessitate members, from the standpoint of loyalty, following the standards set and would eliminate freedom in a choice of methods. Another resolution was to discontinue standing committees, to prepare a list of topics and appoint committees specially qualified for the specific work. Memberships were to expire automatically at the end of the term, but in reconstituting the committee a sufficient number of experienced members should be selected to insure continuity of policy. In this way members who would not work or who were not well qualified would be eradicated.

Research and Standardization

Under research and standardization it was resolved that the society take a more active interest in research by increasing the appropriations from its own funds and by securing funds from other sources, by determining and formulating problems requiring investigation and securing men and facilities to solve them. Standards adopted were to be limited to elements, and standardization of combinations was to be left to organizations devoted to special industries. All standards were to be considered as progressive and not ultimate.

Industrial engineering was considered as a major subject for consideration by the society, and it was the sense of the meeting it should be placed on a par with technical subjects.

The committee approved the work now being done in student branches, but recommended that it be strengthened and that a committee be appointed to look after the interests of the society in industrial education below the grade of college work. There was a field for membership among trained subordinates of engineers and industrial workers.

Owing to requests for the formation of ordnance, power plant, automotive and petroleum sections it was recommended that a standing committee on professional sections be constituted, analogous to that on local sections.

A resolution proposing to make *Mechanical Engineering*, the official organ of the society, a weekly publication received severe criticism and was rejected. It was considered that the expense of issuing the journal four times per month instead of once would form such a large proportion of the income of the society that publishing the paper would become the major work of the society rather than the interests of the members and the advancement of the profession. It would be placing the tail ahead of the dog. Although the monthly was on a paying basis, due to the loyalty of the advertiser rather than a consideration of the returns, there was no assurance that a weekly without advertising solicitors would do equally well. The paper as now printed was giving excellent service, was highly regarded and should be allowed to progress as it had been doing steadily for some time.

Proposed Handbook of Mechanical-Engineering Data

The Committee on Publications and Papers was requested to study the possibility of a substitute for the present expensive method of publishing the transactions and present the plan developed at the annual meeting. As soon as practicable it was proposed that the society publish a handbook of mechanical-engineering data to consist of standards and data of the society and not to conflict with the handbooks already in print.

It was recommended that membership on any council or committee of the society should terminate automatically on account of absence or neglect either willful or due to force of circumstances. Another resolution was to the effect that the joint employment bureau in New York be retained and its activities be expanded and made more efficient; also that the names of employment officials be secured especially through the local sections and that these officials be supplied with lists of men.

It was the sense of the meeting that the present code of ethics was unenforceable for the reason that it had no "teeth." There was a resolution to refer the code to a committee of ethics to be appointed by the president and confirmed by the council.

Following were a series of resolutions to the effect that the council of the society should actively encourage further development of coöperation both in local organization under the leadership of local engineering societies and in state or territorial groups, which can effectively handle state or territorial problems, this coöperation to take such form as will most readily lend itself to national coöperation.

The next step recommended was the creation of an agency of national character through which the coöperation of local groups, state groups and national societies can be secured for the purpose of national scope, the agency to be composed of representatives of the members of the various groups already mentioned and capable of speaking in the name of the profession. Various modes of coöperative organizations were to be collected and published by the society in pamphlet form for the guidance of the various groups or organizations contemplating coöperation.

Acting through the organization previously suggested, service to the community may best be promulgated by securing legislation for the protection of health, life and comfort, the introduction of safety codes, enforcement of smoke prevention ordinances; establishment of standards of size, strength and quality of manufactured products; initiating and guiding legislation for the operation, development and conservation of industries, utilities and national resources owned or controlled by committees; action to secure uniform state and Federal laws for the registration and certification of professional engineers whose work involves public health, safety and well being; the placing of engineers in public positions requiring engineering training, coöperation with and support of engineers in public places, selection of engineers to meet public emergencies, action in conjunction with civic bodies to enforce law, by an active program of education in the press to broaden the public knowledge of and appreciation for engineering achievements. Distinctly technical work was to be done by those technical societies jointly or severally concerned with the particular subject in question.

To the foregoing some objection arose, and Mr. Dow, of the Detroit Edison Co., introduced a resolution to replace those outlined with the idea of avoiding what he considered some of the controversial features in the report of the committee. A lengthy discussion ensued, but the resolution was lost by a narrow vote and the committee resolutions with slight modifications were approved.

As the engineer must devise industrial methods that will insure greater and more efficient production and more equitable distribution of it, he must take the lead in their adoption and often finds himself between opposing interests—an obdurate employer on one hand and the radical laborite on the other. Industry remains to be democratized, and in the process there will be many questions which the engineer should discuss and on which he should be thoroughly posted. With these ideas in view it was the sense of the meeting that the society should enlighten its members on all Federal, state and local problems which should interest engineers and in the solution of which their experience and training may be helpful.

NOMINATING COMMITTEE

A resolution meeting with considerable objection specified that the nominating committee for the election of officers be composed of a member from each local section, provided that each voting member be assigned to some local section by the Committee on Local Sections exclusively for electing a nominating committee member, that members of the nominating committee be elected annually for one year and that no member shall be eligible for more than two consecutive terms. It was proposed to embody the foregoing resolution in the constitution, but it was the sense of the meeting that it might better be incorporated in the bylaws or rules. The procedure for the annual election of officers was to be changed to permit earlier declaration of their election, probably at the spring meeting, and that biographical sketches of all candidates for office should be sent out with the ballot for election.

After all resolutions had been considered, Mr. Marburg, of the committee, introduced several formal resolutions amending the constitution so that the various recommendations favored might be carried into effect.

Professor Greene introduced an amendment to the constitution making the Research Committee a standing committee of administration, which would give its chairman a seat on the council, whereupon Mr. Marburg introduced an amendment to the constitution giving to the chairmen of all standing committees a seat on the council without vote.

On Tuesday there were research sessions lasting throughout the day. Arthur M. Greene, Jr., chairman of the Research Committee, conducted the meetings, and in this capacity naturally presented the first paper, which dealt with the conditions under which research is now being carried on in this country.

The author discussed research in technical schools, giving a list of universities having mechanical-engineering laboratories and research in engineering-experiment stations, with a list of stations and of those publishing bulletins. Coöperative research, activities of the Government and finally commercial and industrial research work including lists of private research laboratories in the country and manufacturing companies having their own research facilities, were considered. Research was considered the keystone of commercial success in this country, in contradistinction to the former hit-or-miss methods. The paper was intended to outline and bring together the numerous research agencies of the country. A number of slides showing various laboratories were presented.

WAR WORK OF NATIONAL ACADEMY OF SCIENCES

Dr. Clevenger spoke of the National Academy of Sciences and its able work following the Civil War, the organization of the National Research Council during the World War and its perpetuation in times of peace to stimulate and organize research.

The speaker outlined the present organization, covering the entire range of science and in particular the division of engineering, consisting in all of 28 members, three from each of the four founder societies, one from each of four important nonfounder societies and twelve members at large. The division was in full coöperation with the Engineering Foundation. It was the stimulator and coördinator of research, and its aim was to get more and better research work done. The work was being carried on by committees made up of leading men in educational institutions, Government bureaus and other sources. The council was not a Government bureau and must receive support from private endowment.

Dr. Mees, from the Eastman Kodak laboratories, told how a laboratory should be organized, outlined the conduct of the work and emphasized the importance of giving publicity to the results obtained. He was not in favor of research work paid for by the Government. Those requiring it would appreciate the work more by paying for it and they would gladly do so as it was a paying investment. On this account the speaker had no concern over applied research, but feared that pure scientific research, or the fundamental things that did not appear to pay, might be neglected. He was heartily in sympathy with the campaign to be conducted by the National Research Council on the necessity of pure research, and it was his plea that it be given the utmost consideration.

A paper by Enrique Touceda gave an interesting account of four years of research work on malleable-iron castings undertaken for the American Malleable Castings Association, which resulted in greatly improving the product of the members and in dispelling many fallacious ideas and theories regarding the physical properties of these castings and the methods of annealing them. The paper offered a striking example of what industrial research among manufacturers can accomplish.

ORGANIZATION AND CONDUCT OF INDUSTRIAL LABORATORY

Dr. H. E. Howe, now with the National Research Council, presented a paper which had been prepared in conjunction with A. D. Little on the "Organization and Conduct of an Industrial Laboratory." The aims of a research organization were outlined, divisions of the laboratory enumerated, methods of management, writing of reports, etc., discussed, with a description of the building and equipment best suited to carry out this type of work. Following were talks by various directors of state engineering-experiment stations, private and other laboratories, outlining the equipment and the character of the work being done in each. All were desirous of increasing the scope and usefulness of their work to the industries and of developing closer coöperation between the laboratory and the interests they concern.

Near the close of the session J. R. Bibbins presented a resolution containing six elements expressing the ideas of the Chicago section of the society on the duties of the research committee. In effect the resolutions follow: First that the Engineering Council should be encouraged to secure passage of a Congressional bill properly worked out for Federal support of general research in state units. Each state had its own problems which it could best care for. Second, encourage research and advancement of the arts among trade, industrial and utility associations. Third, encourage all research institutions now operating or to be established by the Federal and state governments to coöperate with the society in this general research policy Fourth, assist in the establishment and proper equipment of experiment-station research laboratories at the various state universities and help to bring them as closely as possible in touch with vital problems. Fifth, canvass the needs of the industries and direct research work on the coöperative plan, utilizing all available laboratories, both public and private. Sixth, organize and support a separate department of the society's activities in close coöperation with similar departments of other technical societies, to act through the Engineering Council or other representative national agency as a permanent clearing house for all research work.

There was some objection to a national bill, as it was felt that the Research section should not put itself on record as favoring national support, private paying for research being preferable; secondly, that the section should favor every form of research and not any particular method. It was explained by Mr. Bibbins that the formulators of the resolutions were fighting for recognition of the advantages of research among the industries. The object was to assist each state to the maximum possible development of its own resources through a properly organized clearing house, with Government support as far as possible and in addition utilizing every agency. Their slogan was "Millions for Agriculture. Not One Cent for Industry. Why?" The resolutions were favored verbatim.

Industrial Relations Session

On Tuesday afternoon there was a most interesting and prolonged session on industrial relations.

Arthur H. Young, of the International Harvester Co., in his paper, "Industrial Personal Relations," predicted a new epochal era in industry due to the focusing of attention on industrial personal problems. He reviewed the industrial safety-first movements, originating in the Illinois Steel Co. Works at South Chicago; the resulting decrease in accidental deaths and permanent disabilities, and the byproduct results of reduced labor turnover and increased morale of the labor force. The accidental deaths up to 1906, the year the safety movement was started, averaged 47 per year. This number has been cut down to the present low figure of 6 or 7 per year and the results are typical of those in other plants where similar movements have been started.

Started as a purely humanitarian movement, it was found to be good business also. A profit of approximately 100 per cent. has been shown on the investment in educational films, lectures, safety devices and first-aid equipment by the reduction in cost of labor turnover.

The gratifying results secured by this safety movement lead to "employment management." Men were selected for positions on physical and mental qualifications; they were carefully instructed as to their duties and the hazards, if any, of their particular work; and finally they were personally conducted to their place of work and introduced to their immediate superior and a few of their fellow employees.

Still further improvement in labor costs and morale being noted, the conclusion was drawn that intelligent treatment of and consultation with employees might result in progress in other directions. Shorter hours and higher wages need not mean reduced output and increased costs. On this theory, the International Harvester Co., in March of this year, offered to the employees its now widely known "Works Council Plan."

Briefly, this plan provides for a works council for each plant, to which is submitted all questions of working conditions, wages, hours, etc. Half of the membership of this council is elected by the workers by secret ballot and half is composed of plant executives.

The plan was adopted in 19 out of the 20 plants operated by the company. One of the first, and expected, results of putting the plan into force was a request from all plants for shorter hours and higher wages. But after the management's side of the question had been fully and frankly shown, all these requests were voluntarily withdrawn. In the single remaining case the request was granted.

Mr. Young feels that the plan has been productive of much good both for the employees and the company, and while he does not hold it up as a panacea he feels that a long stride forward has been made in solving the complex problem of bringing capital and labor to a better state of mutual understanding and coöperation.

On the status of industrial relations, L. P. Alford, chief of staff of *Industrial Management*, gave a historical summary of the progressive stages in the development of industrial relations since the period immediately following the Civil War and reviewed the new aspects of the problem developing as an aftermath of the World War now ending.

Discussion of Industrial Relations Papers

Among those discussing the two papers, R. P. Geier, Cincinnati Milling Co., brought out the point that the physician could and should play an important rôle in industrial development by concerning himself with industrial medicine. The community concerns itself with public health, sanitation, housing, recreation, etc. Industry, having developed into the large units of the present day, should equally concern itself with the physical, moral and social conditions of its membership.

Fred. J. Miller told of his personal experiences with collective bargaining and gave organized labor a boost for its constructive fair-mindedness.

Boyd Fisher related how capital and labor are striving to get together to achieve greater production in the service of mankind.

Jacob Spitzglass asked of Mr. Young the pertinent question: Why is it that although the International Harvester Co.'s plan seems to conform with five of the six major lines of development as laid down in Mr. Alford's paper, it does not meet the first and, possibly, most important one of profit-sharing?

Mr. Young's reply was that profit-sharing did not seem to rank as high in the thoughts and aims of labor as many employers seemed to think. Personally, he thought that profit-sharing among officers was a sound principle as they could largely affect profits by wise buying, intelligent planning, skillful dispatching, etc. He further said there actually was a form of profit-sharing in the International Harvester Co., but it was based on the principle of thrift. Employees are permitted to buy stock at an advantageous price and under favorable terms of payment.

S. H. Libby, managing engineer, hoist department, Sprague Electric Works, told of the success of the plan in force at his plant, being similar to that of the International Harvester Co. Since December last, the committee on wages and working conditions has brought up only 14 cases for settlement.

Sections Session, Wednesday Morning

At the Sections Session Wednesday morning, under the auspices of the sections of the Mid-West, J. H. Walker, in a paper on "Central Station Heating in Detroit," discussed the general problem of utilizing the heat ordinarily carried away in the condensing water of an electric generating station. Although it was equivalent to about 60 per cent. of the total fuel burned, complete utilization in heating buildings was impossible owing to the great diversity in the rate of use of the two commodities—electric current and exhaust steam for heating. Distance of the large condensing stations from the business center, high cost of current generation in heating plants due to the low load factor, extra labor, small units, the investment charges and the need of larger pipes to conduct exhaust steam were the chief factors influencing the Detroit Edison Co. in using live steam to supply the central heating load. The author described briefly the four boiler plants employed, which contain 17,470 rated boiler horsepower and in 1918 supplied nearly two million pounds of steam to a distribution system serving 2,700,000 sq.ft. of radiation. The distribution system contains about twenty miles of underground mains and two miles of tunnels. Consumers' installations and meters were given attention and special mention was made of transmitting steam through feeders at velocities reaching at times 75,000 ft. per min. and with large pressure drops. No objectionable features had been experienced in connection with the high velocities. Where connection was made to the distributing mains, the diameter of the pipe was gradually increased by special taper fittings to reconvert a portion of the velocity into static pressure. In the mains a considerable pressure gradient was also maintained, but was limited by the safe working pressure of the older piping.

As to load characteristics the monthly sales of steam were closely proportional to the differences between 70 deg. F. and the outside temperature. The annual load factor was about 35 per cent.

Other Papers of the Session

Other papers of the session were: "Production of Liberty Motor Parts at the Ford Plant," by W. F. Verner; "Fire Engines and the Essentials of Fire Fighting," by C. H. Fox; and "Electrical Method for Measuring the Flow of Fluids in Pipes," by J. M. Spitzglass. The paper last named gave the theory and the practical development of a meter now in common use employing an electric current measured by an ammeter and watt-hour meter. The current is so regulated by resistance thrown in the circuit by the differential pressure of the flow transmitted through a mercury column that the indications on the meters represent the amount of fluid passing through the pipe. According to the author, practical difficulties had been eliminated and the result was an accurate, reliable instrument.

There was considerable discussion of this paper. In written discussion Professor Gebhardt expressed the opinion that a variation of voltage in the line might interfere with the accuracy of the instrument. By Mr. Dodge, of the General Electric Co., objection was made to the statement in the paper that the mercury was free to rise to seek its own level, as the instrument had no floats, and that the electrical integration was more accurate than mechanical integration. Mr. Bailey brought up the point that by the use of electric current and a quantity of oil there are two more factors to deal with. Mr. Spitzglass explained that it is the mercury itself that comes to the level, whereas with the float mechanism it is the float. Although electricity and oil were introduced, the facts that the meter has no moving parts and that electrical instruments are far advanced, were worth considering. Owing to the differential pressure causing the oil to move one way or the other, and produce an unbalanced column, the size of the oil chamber as compared to the mercury chamber is about 80 to 1, so that with a maximum mercury deflection the error introduced would be about 0.01 of 1 per cent.

Doings of the Gas Power Session

At the Gas Power Session held simultaneously there were three papers. The first, on "Crude Oil Motors vs. Steam Engines in Marine Practice," by J. W. Morton, gave the various factors to be considered in choosing a form of motive power for war vessels and cargo ships and compared the high- and low-powered oil motors of constant-pressure and constant-volume type with the steam engine. The relative advantages of four-stroke and two-stroke cycle engines and details of operation such as piston cooling, lubricating systems, scavenging pumps, etc., were compared.

D. L. Arnold, in a short paper, suggested a simple horsepower formula for the oil engine. There is a wide variation in ratings and numerous formulas that do not give the same results. By comparing the ratings of 115 engines manufactured by 61 companies the author found that 75 per cent. of them used less than 13,000 cu.in. per brake horsepower. To be conservative, he suggested that this figure be adopted as the equivalent of a brake horsepower. The paper contained further suggestions on a standard name-plate.

In the discussion there was objection to applying any definite number of cubic inches per horsepower, and cases were cited where engines of the same proportions varied 100 per cent. in horsepower delivered, owing to the design of the cylinder. Because of variations in fuel consumption at different loads, others did not wish to be limited to a stereotyped formula. It was explained that the suggestion of using 13,000 cu.in. per min. as a horsepower was intended principally for tractors, which were handled mostly by farmers who did not understand scientific data.

"Standards of Carburetor Performance," by O. C. Berry, was the final paper of the session. New carburetors are usually tested by comparison with another carburetor of high reputation, and the comparative performance of the engine decides the issue. On the basis that a carburetor should be judged on its ability to perform the functions essential to proper carburetion, the author enumerated these essentials and presented data that it was hoped would help establish some of the standards of performance. The discussion turned to automobile practice and the greater difficulty of testing carburetors in this field.

Thursday Morning Fuel Sessions

Thursday there were two morning sessions, one on fuel and the other a general session. The former was largely attended, the drawing card being two papers on pulverized fuel, in which comparisons had been made with stoker operation and with producer gas as a fuel for openhearth furnaces. N. C. Harrison gave costs of preparation, described the plant at the American Iron and Steel Manufacturing Co., Lebanon, Penn., and discussed the use of pulverized coal in stationary boiler plants, the five determining factors in the successful operation of such a plant being taken up in detail. The results of tests on a 468-hp. boiler were given with a summary on pulverized coal vs. mechanical stokers.

"Pulverized Coal for Stationary Boilers," by F. A. Scheffler and H. G. Barnhurst, was the title of the second paper. The authors compared pulverized fuel and stoker plants with particular reference to reliability, cost, adaptability and efficiency. They were somewhat too optimistic in their conclusions and their comparative figures brought out a wealth of discussion, all of which in connection with the papers will be presented in a later issue of *Power*.

A paper by C. R. Weymouth, chief engineer for Charles C. Moore & Co., dealing with the economy of three Arizona steam-electric power plants using oil fuel, was read by title only. The combination of a favorable load factor and high fuel cost not only necessitated but made possible high fuel economy even in the two plants using cooling ponds for condensing purposes. A net kilowatt-hour was produced on less than one pound of oil, or on 18,600 B.t.u., boiler efficiencies ranged from 80 to 85 per cent. and the net production ran as high as 333 kw.-hr. per barrel of oil. The author gave full data in the paper, showing as well the effect on boiler efficiency of steam and oil pressures at the burner and relating some of the difficulties encountered in practice. Mr. Weymouth's paper will be found on page 30 of this issue.

The General Session, Thursday Morning

At the general session there were five papers scheduled. "Elements of a General Theory of Wing Design" was the title of a paper prepared by Walter C. Durfee. A paper entitled "Air Fans for Driving Electric Generators on Airplanes," by Capt. G. Francis Gray, Lieut. John W. Reed and P. N. Elderkin, described the various types of air fans used for driving the electric generators usually installed on airplanes for radio communication. It had been difficult to design a fan that would turn at constant speed with the varying air pressure set up by the machine in flight. The various ways in which this problem was met and the operating characteristics of each type of fan made an interesting discourse.

In a paper on "Mechanical Lifts Past and Present, and a New Method for Their Balancing," Lieut. J. F. Robbins described at some length the various types of mechanical and hydraulic lifts used in canal locks. Of special interest were the particulars of a new type of lift in which the points of support of two counterbalancing loads were so interconnected that the movements of the supporting elements were synchronized and it was impossible for them to get out of level. The author told how such a plan might be applied to freight-car lifts, lift bridges and lifts for canal locks and for launching and dry-docking.

A. A. Adler, in a paper on the "Design of Riveted Butt Joints," derived from Schwedler's graphical method simple general equations to determine the pitch in any row and the efficiency in ideal cases. Using commercial dimensions actual joints were calculated and close agreement was found between ideal and calculated efficiencies. Symmetry exists in the various types of joint. From the quadruple-riveted joint single-, double- or triple-riveted joints may be derived by omitting the extra rows of rivets.

In the final paper, "Economical Section of Water Conduit for Power Development," by C. T. Hutchinson, read by title, the author gave a formula for determining the best slope and size of a conduit for supplying water to a hydraulic plant. Construction costs, the value of the power recovered, the rate of returns expected on expenditures made and other data were considered.

During the convention period inspection trips were arranged to the plants of the Burroughs Adding Machine Co., the Anderson Forge and Machine Shop, the Connors Creek Plant of the Detroit Edison Co., the Eagle and Highland Park plants of the Ford Motor Company.

Entertainment was of the character for which Detroit is famous the country over. The program was perfect, and every detail had been arranged to a nicety. The local committee is to be congratulated. On Monday evening there was a reception and dance, with refreshments, at the Hotel Statler. Mayor James Couzens addressed the audience in a few brief words of welcome. Tuesday evening there was a musical entertainment at the Arena Gardens, with dancing, cards and refreshments. The crowning feature was a trip through the St. Clair Flats on the steamer "Britannia" Wednesday afternoon and evening. The weather was ideal, the scenery beautiful, and this in combination with the entertainment, dancing and refreshments offered made a "perfect day." At a short session on the boat Past President Main talked of the visit to France of the commission of engineers from this country and of the character of the conference while in Europe. During the session the choice of officers nominated for next year was announced as follows: President, Fred J. Miller, of New York; vice presidents, Prof. R. H. Fernald, E. C. Jones and Prof. J. R. Allen; managers for three years, D. S. Kimball, E. S. Scott and D. C. Fisher; manager for one year, C. E. Lord; treasurer, W. H. Wiley.

Ohio State N. A. S. E. Convention

The twenty-second annual convention of the Ohio State Association of the N. A. S. E. was held at Youngstown, June 19, 20 and 21, with headquarters at the Hotel Ohio. The attendance was not up to the standard owing to the stress of business and the hot weather, but this was fully offset by the lively interest manifested by the delegates in the business of the convention. There appears to be a strong desire on the part of the members to accord in every motion or resolution for the uplift and advancement not only of the state organization, but the N. A. S. E. in general. Several resolutions for the improvement of the existing state license law were brought forward and acted upon.

The sessions of the delegates were held in the auditorium of the hotel, and on the same floor and in close proximity a large room was conveniently arranged for the mechanical exhibit of the various supply houses. About forty well-known firms in the engineering field occupied booths.

The opening exercises of the convention took place on Thursday morning with W. L. Shawkey, chairman of the local convention committee, presiding. He told the audience that Youngstown was an ideal city for an engineers' convention because of the immense industrial power plants surrounding the city, and other attractive conditions. He hoped the visit would prove pleasant and profitable. The gavel was then handed to State President Louis A. Kroner, who, after a brief acceptance, introduced the several speakers.

The Rev. J. H. Palmer, pastor of the Grace M. E. Church, offered up the invocation, after which the chairman introduced Mayor A. W. Craver, who cordially welcomed the convention to Youngstown and handed to the president the keys of the city and expressed the hope that he would not forget to return them in good condition.

State President Kroner told of the high quality of the members of the N. A. S. E. and assured the Mayor that Youngstown would be a better city after the visit of the engineers.

Paul J. Jones, vice president of the Chamber of Commerce, was glad to learn that the fundamental principle of the organization was education. He said that never before was there such urgent need for the development of the natural powers of the country and he urged the members to bend their talents in that direction. John A. Matz, state vice president, ably responded.

Samuel B. Forse, national treasurer, representing National President John McKay brought to the delegates the best wishes of the principal officer. He also said that the *National Engineer* was owned by the members and urged that closer attention be paid to its study by the delegates.

John A. Kerley, past national president, said that the best things in the world came through education. He told of the important part played by the engineers in the late war, and the demand that would be made upon them for higher efficiency in the immediate future.

EDUCATIONAL ADVANTAGES OF N. A. S. E.

Robert Patterson, state deputy, was forceful in his praise of the quality of the engineer having a membership in the N. A. S. E. They have the advantages of the blackboard exercises in their locals and many a good job is being held by men who owe their merit and high rate of wages to their close attention to the teachings of the association.

The convention then went into executive session, and after the necessary committees were appointed, an adjournment was taken until 2 p.m.

On Thursday evening an entertainment, under the auspices of the engineers, was given in the auditorium of the hotel. The audience enjoyed several numbers given by local talent and Jack Armour, of *Power*. W. L. Shawkey was the master of ceremonies.

On Friday afternoon automobiles were furnished for visits to the many places of interest about the city, ending in an inspection of the immense manufacturing plant of the Youngstown Sheet and Tube Mills, and on Friday evening the A. M. Byers Co. gave a motion picture lecture showing the making of wrought-iron pipe from the ore to the finished product.

At the final session of the convention on Saturday morning the following state officers were elected: Louis A. Kroner, past president; John H. Matz, Cincinnati, president; W. L. Shawkey, Youngstown, vice president; George P. Klasgye, Cleveland, secretary; Thomas S. Garret, Dayton, treasurer; Frank B. Seidel, Tiffin, conductor; P. W. Gray, Ashtabula, doorkeeper; Robert W. Patterson, Akron, state deputy.

Retiring State President Louis A. Kroner was the recipient of a past president's jewel and a cash honorarium.

It was decided to hold the next convention at Columbus, in June, 1920.

Canadian Industrial Congress

Western Canada is to have a great industrial congress Aug. 11-16, to which manufacturers and industrial leaders of the continent, as well as those of the United States, are being invited. The discussions are to be made by men foremost in industry and industrial science. Among those who will speak are Sir Robert Borden, Henry Ford. Harold McCormick, E. W. Beatty and Robert Dollar. The congress dates are Aug. 13 and 14, at Calgary, though a trip through the territory including these cities will begin at Medicine Hat Aug. 11, and will conclude at Edmonton, the capital city. All interested in industrial development in the West, or in Western markets, are invited to attend

Co-operation a Factor in the Solution of Our Economic Problems*

BY COMFORT A. ADAMS

COMFORT A. ADAMS

SINCE the last annual convention of this institute the greatest war in the world's history has come to an end. Millions of lives have been sacrificed. Millions of men have been crippled in greater or less degree. Wealth to the extent of many billions of dollars has been destroyed. Most of the nations involved have been seriously impoverished. The whole social, economic and industrial order has received a severe shaking up and has in some countries been completely overturned. Widespread dissatisfaction with the old order prevails in nearly all of the countries involved in the war. Unrest is generally prevalent, and however unreasonable the demands of the restless may seem, there probably is a reason. In any case, "It is a condition, not a theory that confronts us." The old order has failed and can never wholly return. What will be the new order? What are we going to do about it? Are we as engineers, educated men, who pride ourselves on our breadth of vision, who complain because we are not properly recognized in large questions affecting the public welfare, going to crawl back into our little cabins and leave the steering of the ship to those we consider incompetent? Are we going to use our influence to keep the ship on the old course, in spite of the fact that it led to the rocks? Or are we going to ask the same question we ask when our engineering plans result in failure, namely, why? That is, are we going to scrutinize the ship's log to see why she ran on the rocks and then revise the sailing orders accordingly?

These are some of the questions the consideration of which has urged me to deviate somewhat from the custom established by my predecessors, of discussing either institute activities and policies or general engineering questions, in order to present a much broader question, of interest to us not only as engineers but also as citizens—a question that has repeatedly arisen in connection with my work for the institute during the last two years.

Every commercial transaction of the greatest or of the least magnitude, between individuals, or groups of whatever size, is made on the assumption that it is profitable to both parties concerned, otherwise it would not ordinarily be made. Every such transaction involves a certain degree of coöperation, a certain degree of faith or confidence in each by the other. The more the mutual confidence and the coöperative spirit, the freer and the more efficient will be the interchange and the greater the mutual profit.

The obstacles to coöperation, particularly between the larger units, are of two varieties—material, and human or intellectual. The chief material obstacles are space coupled with imperfect means of communication and transportation, differences in language, differences in coinage, weights and measures, and duties or tariffs. Some of these bear obviously only on international coöperation. The chief intellectual obstacles are tradition, custom, prejudice, suspicion, distrust, jealousy, narrow-minded and short-sighted selfishness or greed, or in general ignorance and lack of understanding one of the other. Most of this latter group bear upon minor or internal as well as upon international coöperation.

Consider first the work of engineering and industrial standardization. The work of the Standards Committee of this institute is second to none in its own particular field or in any other, either in this country or in any other country, in spite of the fact that the ground covered is a peculiarly difficult one. Why this success? Simply because of the coöperative spirit that has prevailed. Conflicting interests come together, pool their experience, share the work, place their cards on the table face up, and finally agree to abide by the resulting rules.

But this coöperative spirit does not always prevail, in fact rarely in the degree found in our Standards Committee. Until very recently the French National Committee of the International Electrotechnical Commission contained none of the designing or manufacturing engineers, it being assumed that the latter would be biased and partisan in their attitude. As a result the manufacturers formed a syndicate with a committee and standardization rules of its own, which were and even now are to some extent the rules generally employed in France, although much inferior to our own. In some cases the American rules are specified. Even now the French rules originate in the manufacturers' syndicate and are passed on to the French National Committee for their approval, with a consequent loss of time and efficiency.

As the work of our own Standards Committee expanded, we found it overlapping the work of other societies in adjacent fields, and coöperative relations were established. This failed from the lack of any suitable and generally acceptable coöperative machinery. A movement was then started by the institute more than two years ago to organize a central body (the American Engineering Standards Committee) to coördinate all the work of engineering standardization being done by the various engineering organizations. The objects of this organization are to avoid overlapping, duplication of effort and the confusion of conflicting standards; to insure the employment of an effective and sound procedure in the development of standards, to the end that a standard, when promulgated, may not only be workable but also acceptable to all concerned, and the only accepted standard of its kind; to stimulate desirable standardization and at the same time to shut off premature or ill-advised attempts at standardization.

The consummation of these objects will mean: An enormous saving of effort in the production of standards; a tremendous increase in the value and usefulness of standards; and, when the work is brought up to the needs of the time, an incalculable saving in the cost of production and the productivity of labor. International standardization will be a tremendous stimulus to foreign commerce, but such international standardization is in most cases exceedingly difficult without a central authoritative body with which similar foreign bodies may coöperate. Several instances of this difficulty which have actually arisen during the past two years could be cited, if time permitted. These have resulted in hopeless confusion, misunderstandings and waste of time and money.

Great Britain has its Engineering Standards Association, which, during its eighteen years of life, has demonstrated its reason for existence and its value to industry and to the government. Its work in aircraft standards alone, which it is doing on behalf of the government, involves some fifty-odd subcommittees.

France now has its permanent standards commission, a little more than a year old and just getting under way.

Holland also has its Normalization Bureau for the same purpose, and Switzerland is just starting a movement in this direction.

With all these national bodies our American Standards Committee has already established coöperative relations.

The American Engineering Standards Committee, although organized last October, is now in process of reorganization.

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*Abstract from an address delivered at the 35th annual convention of the American Institute of Electrical Engineers, held at Lake Placid Club, N. Y., June 24 to 27, 1919.

May we not look to every member of this institute to take part in a campaign of education and in the development of that whole-hearted spirit of coöperation which will mean the support rather than the hindrance of many well meaning but timid objectors to this movement, which seems to promise so much in the development of our industries, in the increase in the productivity of labor and in the breaking down of at least one of the barriers of international misunderstanding?

Another fertile but as yet little cultivated field for coöperation is that of industrial research. Here we have a field where the obstacles of the second group are especially dominant, particularly short sighted self-interest and corporate interest, and the timid desire for secrecy.

Consider for a moment the advantages of coöperative research. Few individual corporations except the very large ones can afford either a suitable research laboratory or competent men to conduct the work. The result is that most of the research work is superficial and much of it misleading. The total cost is many times greater than of a comprehensive coöperative research led by the foremost experts in the particular field. Moreover, some of the most vital and fundamental researches are either beyond the capacity of even the largest corporation laboratories or have to be postponed for those offering more chance of immediate returns.

Now just a word as to a specific and very serious problem, namely, that arising from the world-wide unrest in the labor group. That this condition exists must be admitted by the most optimistic. To ignore it is suicidal. It is difficult to characterize this condition in a few words, as there so are many degrees of radicalism and of revolutionary spirit represented; but it may be safely stated that on the average, labor is unreasonable in its demands and seems to fail to realize that it cannot receive more wealth than it creates, or at best it has an exorbitant idea as to the value of what it creates. For example, in England labor is not only demanding higher wages, but according to all reports is reducing the hourly output as well. There seems to be a prevailing notion in labor circles that the excess profits of the capitalist constitute a limitless supply which only needs the tapping; or to put it in another way, the labor group is trying to use their organized power as a monopoly, and to insist on "all the traffic will bear." The revolutionary element goes even further than this in their demands.

It is very easy to criticize and condemn this attitude because of its unreasonableness, looking down from our superior height of intelligence. It is very easy to assume that it is merely a matter of showing the laborer the error of his ways and of forcing him into line. But would it not be wiser at this time to examine our own attitude with equal care, to make sure that we are setting an example which, if followed by labor, would solve the problem? Is demanding all the traffic will bear under the pressure of organized labor any worse than the same policy carried out by the capitalist whenever he has the monopoly grip? Unfortunately, the two cases are not treated the same by our laws; labor monopoly is not subject to the same limitations and responsibilities as is capital monopoly; that disparity should be removed.

What can we expect of labor in the way of intelligent fair-mindedness if we, with our superior knowledge, encourage the perpetuation of institutions which work for serious injustice to the many for the benefit of the few, or even if we allow them to persist because of our lack of intelligent fair-mindedness.

My opinion as to the seriousness of the present world situation, as to the importance of the problem before us, is not mine alone, but that of many thinking men in this country and in others. I have talked with many influential men in France and England and have found a striking unanimity on this point.

May we not as engineers utilize our training and experience, our method of thought of which we are so proud, to encourage clean, straight, unbiased and fair-minded thinking, and to encourage that broad, generous, coöperative spirit which will mean so much in breaking down the barriers that separate classes within a nation, as well as the nations themselves, and which is essential to the solution of the world problem which is knocking so hard at our door.

A. I. E. E. Thirty-Fifth Annual Convention

CALVERT TOWNLEY,
President-elect, A. I. E. E.

FROM June 24 to 27 inclusive the American Institute of Engineers held its 35th annual convention at Lake Placid Club, N. Y. Approximately 400 members and guests registered. The convention was opened at 10:30 a.m., June 24, by the presentation of the annual presidential address by Comfort A. Adams, in which the great need of closer coöperation both in commercial, industrial and scientific transactions was emphasized. An abstract of this address appears on page 38 of this issue.

After delivering his address President Adams introduced President-elect Calvert Townley, who in a short address expressed his appreciation of the honor conferred upon him in being chosen as the president of the institute for the coming year. He said, much as he appreciated the honor, this was only secondary to the opportunity that the office afforded to do something for the institute. He called attention to the tremendous work that the engineer had done toward winning the war by coördinated effort, and expressed the opinion that the possibilities for the engineer making a prosperous period of peace was many times greater, providing he took advantage of his opportunities.

Before the meeting was turned over to a consideration of technical papers, at the request of the president the audience arose and remained standing in silence for a short period as a tribute to the members who had paid the supreme sacrifice in the great war.

The remainder of the session was devoted to the presentation of three papers under the auspices of the Protective-Device Committee. The first paper, "Present-Day Practice of Transmission- and Tie-Line Relay Protection," by H. R. Woodrow, D. W. Roper, O. C. Traver and P. MacGahan, was presented by Mr. Woodrow; the second, "Grounding the Neutral of Generating and Transmission Systems," by H. R. Woodrow, was presented by the author; a paper on "Grounded Neutrals," by W. E. Richards, in the absence of the author was presented by O. C. Traver.

The paper on "Present-Day Practice and Transmission- and Tie-Line Relay Protection" is a summary by the Protective-Device Committee giving the results of an analysis made of the transmission-line protective-relay situation throughout this country, by obtaining experiences of operating companies with this type of protective apparatus. Questionnaires were sent to 62 operating companies asking for their experiences and present practices in regard to relay protection; 32 companies replied. The nomenclature used by the different operating and manufacturing companies for the various classes of relays was found to be not in harmony, therefore the committee undertook the work of its standardizing, and this proposed relay nomenclature is also given in the paper.

The paper on "Grounding the Neutral of Generating and Transmission Systems" gives the methods of grounding the neutral on the New York Edison Co.'s power system, which is made up of four systems: A 6600-volt 25-cycle:

a 7800-volt 60-cycle; a 16,000-volt 25 and 60-cycle, and a 25,000-volt 25-cycle system.

The discussion brought out the opinion that the present type of relays did not give all the protection desired in the modern large power systems. Considerable of the discussion centered around the maximum time setting of the relay, it being recommended in the paper that two seconds should be the maximum on short-circuit conditions. It was brought out in the discussion that at least one large system was operating with relay settings as high as eight seconds and has never had a case of cable failure on account of long-time relay settings. However, on the New York Edison Co.'s system it has been found necessary to use a setting of even less than two seconds to take care of the short-circuit conditions which caused peak currents as high as 200,000 amperes to be delivered into the failure. Attention was called to the effects of timing relays on cable failures, experience having shown that with instantaneous settings a failure to ground would only cause a small hole to be burned in the lead sheath, without short-circuiting the cable, before the oil switch would open. The damage to the cable increases with the time required by the relay to open the oil switch, until on a setting of two or three seconds two or three feet of the cable would be burned away; and if the time setting was made too long there was danger of the arc burning through to other cables in the duct system. Good results were reported from the use of low-voltage storage batteries for tripping hand-operated oil switches. Both primary batteries have been used at pressures ranging up to about 12 volts. In some cases a preference was expressed for the use of dry cells.

DOINGS OF THE WEDNESDAY MORNING MEETING

At the Wednesday morning meeting the annual reports of the technical committees were presented.

In the report of the Power Station Committee it was announced that the committee has had under consideration for the last two years and will shortly present to the institute, the subject of "Limits of Speed and Power of Single-Shaft Steam Turbo-Generator Units." Three papers are being prepared, two covering the steam end and one the electrical end. Since the study was first considered, its realization having been retarded by the war, there occurred three or four serious mechanical failures of steam-turbine wheels which have created considerable concern to the users and aroused a wide-spread interest in one phase of this theoretical subject. The erroneous remark is often heard that it is unsafe to go beyond a certain limit in the capacity of units for central stations. In reality, units of twice or three times the power of the largest existing units can be manufactured to have the same or even greater factor of safety. Possibly such units may be more costly, or less efficient, or too heavy, or of too large dimensions, or be undesirable in situations where they would concentrate all the power of a station in two or three units instead of five or six or more, but we should not dismiss the study of the possibility of such machines simply from the wrong assumption that they cannot be made as safe as smaller-capacity units, because in some situations the larger units may yet prove to be of advantage.

In the report of the Instruments and Measurements Committee the effects of the war are reflected in the statement: "Prior to the war thermoelectric couples had been employed for measuring low values of alternating current. These couples were almost exclusively of German manufacture and neither extremely accurate nor sensitive. There have since been developed and put on the market thermoelectric couples of American manufacture which are superior in every way and are now available for the accurate measurement of alternating currents of any frequency. Their sensitivity is such that a current of one milliampere will produce a deflection of three milli-volts in a direct-current voltmeter."

It is stated in the Iron and Steel Committee's report that the increase in the use of electrical energy in the iron and steel industry in the last few years has been remarkable and partly responsible for the prominent position the United States has taken in furnishing steel products to the entire world. Over 500 motor equipments are in use in this country, driving main rolls with a maximum horsepower of over 850,000, while the total horsepower of auxiliary motors exceeds 1,350,000, making a total of 2,200,000 hp., which requires about 650,000 kw. in generator capacity. In addition, electric furnaces require approximately 250,000 kw. in generator capacity, or a grand total of 900,000 kw. generator capacity in the iron and steel industry. This is by far the largest amount of electric energy required in any one industry, and from all indications will continue to increase considerably in the future.

FUTURE POLICIES DISCUSSED

On Thursday morning a conference was held under the auspices of the Committee on Development, in which the future policies of the institute were discussed. The possibilities are that in the near future there will be a number of changes made in regards to the scope and work of the institute to meet the needs of the rapidly increasing membership. Friday morning's technical session was held under the auspices of the Transmission and Distribution Committee and four papers were presented: "High-Tension Single-Conductor Cables for Polyphase Systems," by W. F. Clark and G. B. Shanklin; "Electrostatic Field in Electric-Power Cables," by R. W. Atkinson; "Commercial Problems of 220-kv. Power Transmission," by A. E. Silver, and "The Effects of Transient Voltages on Dielectrics—II," by F. W. Peek, Jr.

A. E. Silver in his paper considers the problems of 220-kv. power transmission and suggests 220-kv. as the logical voltage for high-capacity, long-distance transmission of energy from distant coal fields and water-power plants. The author discusses very fully the important problems introduced by large concentration of energy at high voltage and covers in detail the economic and technical considerations underlying the design of a 220-kv. system. The paper indicates that while further investigation and research are necessary for a complete solution, established principles of design and present types of equipment can, with minor changes, be adopted for 220-kv. transmission.

New Jersey N. A. S. E. Meets

The annual meeting of the New Jersey State Association of the National Association of Stationary Engineers was held at Bayonne, June 7 and 8, presided over by James S. Heath of Elizabeth. National Vice President John J. Calahan was present, reporting the unusually excellent progress of the New Jersey Association, data about which is reported to him as national deputy.

There was a noticable tendency on the part of some delegates to criticize the work of the Engineers' and Firemen's License Bureau of the State Department of Labor; but appreciation of the Bureau's unavoidable difficulties led others to head off the censure.

The vigorous work of the Educational Committee, now headed by C. L. Johnson, and of the Visiting Committee is beginning to have its effect. New Jersey now stands third in membership in the national organization, having 1403 members and 13 associations. Considerable discussion was had on the appropriation for the Educational Committee. To set the members right on costs, Charles H. Bromley, of the committee, showed that the service given costs each member but 0.2c. per week.

The following officers were elected: Val V. Secor, Phillipsburg, president; George W. Armitage, Atlantic City, vice president; A. B. Meincke, Newark, secretary (reelected); John Mycock, Trenton, treasurer; J. J. Shney, Perth Amboy, conductor; J. J. Gallagher, Bayonne, doorkeeper.

Phillipsburg is the next convention city. The convention decided to give all possible support to Atlantic City as the place for the 1920 national convention.

In Japan a little more than 1,000,000 hp. of water power is under lease for exploitation, about half of which being under exploitation or in process thereof; while about 5,000,000 hp. has not yet been placed under exploitation, although it is estimated to be worthy of future economical development.

Engineering Council Notes

Contributed by M. O. Leighton, Chairman
National Service Committee

Before the writer is a pamphlet in which the following statement appears:

> Let those who may shun the proper organization of the States and of the General Government for the systematic construction and maintenance of public works think of one thing: No nation has yet existed that was wholly without them, and this nation, no less than most or all of its states, in spite of all obstacles, has had them and *is constantly having them.* The question becomes reduced, then, to this simple proposition: Shall our public works be built and, what is of equal importance, maintained in a proper, businesslike manner, getting year by year a dollar's worth for a dollar's expenditure, or shall the shiftless hand-to-mouth method of procedure, which looks not forward and hides its shiftlessness by denying that we have any public works—shall this wastefulness of the public funds be allowed to continue?

The author of the pamphlet from which the foregoing is quoted is M. Clemens Herschel, Member American Society of Civil Engineers, and the date is Oct. 28, 1884. Mr. Herschel is one of the few public works department pioneers who still remain among us, and it will therefore be of interest to read what he has to say 35 years subsequent to the date of the foregoing.

New York, Feb. 17, 1919.

Mr. M. O. Leighton,
Chairman National Service Committee of Engineering Council, McLachlen Building, Washington, D C.

Dear Mr. Leighton: Responding to the requisition you make upon me, as a member of the Engineering Council, to write out the arguments and a plant for a Department of Public Works, to form part of the Government of the United States, I comply in brief form.

It appears no longer to be necessary, as I can well remember it was necessary in times past, to argue that public works are an essential accompaniment of a civilized state. Formerly such works were, with us, called "Internal Improvements," and schools of political philosophers spent much time is proving, from their view of the Constitution of the United States, that private enterprise was all sufficient, and necessarily should be allowed solely to construct them; and again, the reverse of this proposition. That day has gone by. What Henry Clay thought about it, what those opposed to him wanted done on those lines, are both of small importance at the present day. This is a present-day nation of 110 million inhabitants, not a parcel of pioneer colonies, beginning to develop as a modern state. This is the year 1919, not 1819, when the building of the Wheeling turnpike and of the Erie and other canals first brought the Government at Washington face to face with the need of a governmental executive agency for the design and construction of public works; not to mention their repair, maintenance and operation after they had been completed.

The first use of the word engineer, as is well known, came from the exercise of refined military work. And there were none but military engineers, no others certainly in English-speaking countries, until about 1780, some 40 years before the rise of the discussion concerning "Internal Improvements" in the United States above spoken of.

Later, in America, there were, to be sure, surveyors—George Washington had been one of them—but no engineers that were noticeable, except the graduates of West Point, and other military engineers that had been imported for, and had survived from, the Revolutionary War. And so the country turned for its civil engineering, for its turnpikes and canals, to the Department of War. As an emergency measure, designated members of the Corps of Engineers, U. S. Army, were temporarily detailed to supervise the construction of these works.

The wide world over, there are today but two systems of providing for the construction and operation of public works: (1) Either to ignore the necessity for their existence in a civilized state and thus provide for them by emergency measures; or else, (2) to consider them as forming part of the every-year work of the government of a civilized state and provide for them in the fundamental law governing such states, in the same way that Departments of War, Navy, Treasury, even bodies exercising police powers or the judiciary, are provided for.

The great exemplar of relying for all public works upon private enterprise is England. When public works had to be built, harbor works, works of water supply, metropolitan sewerage, and others, the emergency system was followed. For each case a select body of laymen, a so-called commission, would be appointed, and an emergency corps of civil engineers gathered as an executive agency. The commission would studiously, and in some measure, qualify itself for its task; works would be executed, and the whole organization would then dissolve into its original elements. Of course there are exceptions to and variations from this normal state of affairs. And England, it may be said, has grown heartily tired of its want of organization for purposes of constantly recurring and as constantly necessary work, which has been described. The light is beginning to break in upon them, as it must sooner or later upon the imitators of England—the United States, and the dependencies of Great Britain.

The English system of emergency measures are an anomaly in these days of a striving for efficiency, and are gradually changing for a better system of carrying on the normal year's work of the Commonwealth, both in England and in the British Dominions. That the United States and the 48 state governments are moving and will continue to move in the same direction many signs indicate.

The other method for a state to care for its public works, a host of our civil engineers and others have no doubt recently seen in operation, even in war times, in France; and it is the same in all the other European Continental countries. The Minister of Public Works, an important member of the Cabinet, stands at the head of the organization. In the United States, let me say at once, the Secretary of the Interior could, without much disturbance, be converted into such a Secretary for Public Works.

His former principal duties, those relating to public lands, and to the wards of the Nation, the Indian tribes, are rapidly becoming obsolete, and would naturally be followed by those relating to other constantly obtaining domestic needs of the country

See how the engineering requirements of the United States are now distributed among the departments, with much unavoidable duplication and waste of work.

LIST OF ENGINEERING BUREAUS OR COMMISSIONS
Under Various Executive Departments of the United States Government

Treasury: Supervising Architect, Public Health Service.

War: Construction Division of the Army, River and Harbors, Public Buildings and Grounds, Mississippi River Commission, California Débris Commission, Engineering in Philippines, Porto Rico, etc.

Navy: Steam Engineering, Civil Engineering, Docks, etc., Experiment Stations.

Interior: General Land Office, All Land Surveys, Geological Survey, Bureau of Mines, Reclamation Service, National Park Service, Alaskan Engineering Commission, Engineering in office of Indian Affairs.

Agriculture: Roads and Engineering, Forestry Engineering.

Commerce: Coast and Geodetic Survey, Bureau of Standards, Bureau of Lighthouses.

The great change that must come, if public works are do the permanent civil engineering work of the United is that of constituting a permanent corps of civil engineers to do the civil-engineering work of the country, under a Secretary for Public Works such as described. It is the only efficient way. Organizations built up as emergency measures must give way to it. Army organizations can readily confine themselves to the work of the Army, and let a commissioned, permanent body of U. S. civil engineers to do the permanent civil engineering work of the United States.

Yours very truly,
Clemens Herschel.

American Boiler Manufacturers' Association Meets

The thirty-first annual convention of the American Boiler Manufacturers' Association was called to order at the Lafayette Hotel, Buffalo, promptly at 10 o'clock on Monday, June 23, by President W. C. Connelly. Richard Hammond, charter member and past president of the association and a resident of Buffalo, spoke a few words of welcome.

Reports were submitted by E. R. Fish and Charles E. Gorton regarding the work of the Uniform Boiler Law Society.

H. N. Covell, secretary and treasurer, reported the association in a flourishing condition financially and otherwise, with no resignations, 8 new member companies and 4 new associate members during the year, making 86 active member companies. Dr. D. S. Jacobus presented a paper on "Methods of Increasing Boiler Room Efficiency."

The annual address of the president was the first business of the afternoon. Excerpts from the address follow:

Perhaps the most serious of our readjustment problems pertains to labor. Many of the large activities of a year ago no longer exist, and industry for several months past has been shifting from "war needs" to "peacetime needs." This adjustment is practically made and in much less time than most of us had even hoped for.

During the war Government control was largely in effect and in some instances Government operation of industry was in vogue. The latter has proved so great a failure, from both an operating and a financial viewpoint, that I believe this association should do as others have been doing and pass a resolution calling for prompt return to their owners of all semipublic or private companies which the Government has been operating.

The subject is a large one, and I do not wish to be understood as having expert knowledge of it—but I do know that American industry cannot carry as heavy a taxation burden as now exists, and prosper.

There can be no lowering in the cost of living while the present high rate of wage, which prevailed during the war, continues. It must be plain to anyone who has given the subject the least thought that labor is the "base of all costs"—therefore, as the cost of labor advances, so will those things which labor needs in its everyday life advance. At present, the steel which all of us purchase costs about 100 per cent. more than it did before the war, and the labor we put on to that steel in the manufacture of boilers costs about the same percentage additional, with the result that we are obliged to sell our finished product at about 100 per cent. above its former price.

An organization or Federation of American Industries was established in 1916, having headquarters at 15 Beacon St., Boston, Mass., and it might be desirable to empower your Executive Committee to study the work of the National Industrial Conference Board, with a view of lending our moral and financial assistance.

I offer the opinion that 50 productive hours of labor per week is the point at which American industries must stop, and this total be divided into five days of nine hours each, and one day of five hours.

It is time to make a stand that industry cannot survive on tools, buildings, etc., idle more than 66⅔ per cent. of the time.

The president offered the following recommendations:

In the interest of standardization we should all agree to build nothing but A. S. M. E. boilers.

That technical and trade papers carrying advertisements of boilers built by members of our association be requested to properly group these advertisements on successive pages.

That a committee make a study of the workman's compensation laws of the various states, with a view of harmonizing, as nearly as possible, the rates of insurance for our industry, and also to find out what it has cost the various states to carry our risks, as against the amount of premium we have paid in.

That builders of fire-tube boilers (especially horizontal return-tubular type) compile a standard form of specification and cover all of the items requisite to a good setting.

That the convention consider the holding of quarterly or semiannual meetings of this association, for the purpose of general advancement.

In conclusion the president said:

I wish to express my grateful appreciation of the efforts and encouragement of all the members of your Executive Committee in advancing the work of the association. I also feel that special mention should be made of the services rendered by the War-Service Committee, consisting of Messrs. Barnum, Fisher and Bach. The amount of time these gentlemen have given to this work can only be appreciated by those who, like myself, had the opportunity of knowing. I should be derelict in my duties if I failed to mention the services of Mr. Covell, as secretary and treasurer of this organization. At no time in the past year have I asked for aid on association matters that it was not forthcoming promptly. I again extend my thanks to all our members for their loyal support. The friendships which have come to me from these meetings I greatly prize, and hope that each of you have had an equal amount of pleasure from them.

A discussion regarding the registering of boilers in the state where they are made and in the state into which they are shipped was led by E. C. Fisher.

A discussion regarding the use of trade acceptances in the settlement of accounts receivable and also of accounts payable followed.

A proposal to standardize pressures for water-tube boilers at 160, 180, 200, 225, 250, 275 and 300 lb. was adopted unanimously by the representatives of the water-tube boiler manufacturers present and 100, 125 and 150 lb. by the manufacturers of horizontal return-tubular boilers.

A. G. Pratt of the Babcock & Wilcox Co. gave the following figures for 1918 and 1919:

(1918)			Per Cent.	
Pressure	Jobs	Boilers	Jobs	Boilers
160	257	515	53 6	45 4
180	19	38	4 0	3 3
200	167	434	34 8	38 2
225	13	53	2.7	4.7
250	17	64	3 5	5.6
275	2	8	0.4	0.7
300	4	17	0.8	1 5
350	1	6	0.2	0 5
	480	1135	100.0	99 9
160	80	161	61 1	63 2
180	6	21	4.6	8 2
200	37	58	28.2	22 8
225	6	12	4 6	4 7
250	2	3	1 5	1.1
	131	255	100.0	100.0

These were not normal years and the figures are quite different when computed by horsepower instead of by boilers, but they are interesting as they stand.

The remainder of the afternoon was taken up with a topical discussion of the proportions of boiler settings, which will be treated at length in a future number. Tuesday forenoon was devoted to an executive session.

Activities of the American Association of Engineers

F. K. Bennett, president of the Twin City chapter of the American Association of Engineers, has been appointed chairman of a joint engineering committee representing the Engineers' Club of Minneapolis and the Twin City chapter of the American Association of Engineers. The duties of this committee will be to help in the solution of engineering problems arising in connection with the settlement of the street-railway franchise in the Twin Cities.

A permanent organization of the Portland, Ore., chapter of the American Association of Engineers has been effected. A committee of the Oregon Society of Engineers has been appointed by its Executive Board to work out plans for amalgamation with the American Association. A tentative plan has been drawn and was submitted to the national board of directors of the A. A. E.

At the convention of the Southwestern Society of Engineers, held in El Paso, May 29 and 30, the board of the society voted unanimously to recommend to its members that the Southwestern Society come into A. A. E. as a body. The tentative plan is to charter the Southwestern Society as the Southwestern District of the A. A. E.

The Navy Technical Association, consisting of 700 civilian engineers in navy yards at Boston, Newport, Hartford, New York, Schenectady, Philadelphia, Washington, Norfolk and Hampton Roads, has been amalgamated with the A. A. E. Final steps were taken by delegates of the Association at its convention in Washington June 8-9, and the arrangement was approved by the National Board of Directors of the A. A. E. at its meeting June 14.

The A. A. E. has employed B. C. Baily, president of the N. T. A. and formerly expert aide at the Brooklyn Navy Yard, as its assistant secretary in Washington, D. C.

When the suction pipe of a pump has been installed, it should be tested at from 35 to 50 lb. hydraulic pressure, for even a minor leak will furnish a sufficient quantity of air to impair the pump's action. The suction line should be thoroughly inspected for tight connections.

Personals

E. B. Katte, well-known electrical engineer, who has been for many years chief engineer of electric traction of the New York Central R.R., has been elected president of the New York Electrical Society.

Van H. Manning, director of the United States Bureau of Mines, Washington, had the honorary degree of doctor of engineering conferred upon him at the recent commencement of the University of Pittsburgh, in special recognition of his activities in aiding the winning of the war.

Eugene L. Brown, Jr., has recently been discharged from military service, and has accepted the position of chief engineer of the stoker department with the Plymouth Manufacturing Co., Chicago. Before entering the Army, Mr. Brown was connected with the Illinois Stoker Co., Alton, Ill.

Major Charles E. Sholes has been elected vice president, director and general sales manager of the Edison Storage Battery Co., Orange, N. J., to succeed Harrison G. Thompson, who resigned to organize and conduct the Transportation Engineering Corp., of New York. Major Sholes has heretofore been identified with the construction, operation and management of chemical industries.

C. S. Coler, who has been successively director of mechanical drawing in the Casino Technical Night School, an institution supported by the Westinghouse company to promote the education of the young men and women working for the company, manager of the entire evening school, and director of the trades training of the company, has recently been appointed manager of the educational department of the company and president of the Casino Technical Night School. This appointment was made possible by the resignation of C. R. Dooley, who has accepted a position with the Standard Oil Co. to promote educational work in that organization.

Engineering Affairs

The Ohio Electric Light Association will hold its annual meeting at Cedar Point, Ohio, July 15-18, with headquarters at the Breakers Hotel.

The American Association of Engineers formed a new chapter at Dallas, Texas, May 23, which resulted in the organization of a Dallas Engineers' Club to include all engineers of the city.

The Association of Iron and Steel Electrical Engineers, Birmingham (Ala.), Section, will hold an outing on July 4 at the hydro-electric plant of the Alabama Power Co., on the Coosa River.

The Brooklyn Company Section, N. E. L. A., held its annual meeting in the auditorium of the Central Y. M. C. A., Brooklyn, on the evening of June 10, over 500 being in attendance. The meeting was called to order by the chairman, R. W. Allen, who presented his annual report, with which was incorporated reports of the treasurer and the following standing committees: Editorial, Meetings, Membership, Papers and Competition, Speakers and War Activities. The reports showed a very active year in the Brooklyn Section under the unusual and uncertain conditions existing during the war period, and that following the signing of the armistice. All the meetings of the section were thrown open to all employees of the company, whether members or not, and no especial membership drive was attempted. Following the report of the chairman, H. M. Cook presented a report on the Atlantic City convention, outlining in detail the work of several of the sessions. The feature of the evening comprised several addresses by men who left the company to take active part in service abroad. These addresses were varied and full of human interest, being greatly enjoyed by all present. E. A. Baily, who was elected chairman of the section for the coming year, on behalf of the company, presented to Past Chairman Allen the past chairman's gold watch fob, which insignia is awarded by the Brooklyn Company to each past chairman of the Brooklyn Section in recognition of his services. The meeting concluded with a motion picture and a selection by the orchestra.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg ...	$7.80@7.95
Stove	7.95@8.15
Chestnut.	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons.....	$2.15@2.75	$2.75@3.25
Philadelphia, gross tons....	4.27@4.95	5.95@5.50
New York, gross tons	4.62@5.29	5.29@5.85
Alongside Boston (water coal), gross tons........	6.10@6.85	6.90@7.55

Pocahontas and New River are quoted at $4.70@5.25 f.o.b. Norfolk and Newport News, Va., for spot coal, and $7.20@8.60 alongside Boston, these prices being on a gross ton basis.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Company Circular		Mine	Company Circular
Broken	$6.05	$7.90	Pea.....	4.90	6.65
Egg	5.95	7.80	Buckwheat	3.40	5.15
Stove..	6.20	8.05	Rice.	2.75	4.50
Chestnut...	6.30	8.15	Barley.	2.25	4.00

Bituminous

	Spot	Contract
South Forks...	$2.90 @ $3.25	$2.95 @ $3.50
Cambria County (good grades).....	2.75 @ 2.95	2.95 @ 3.25
Clearfield County...	2.50 @ 2.75	2.80 @ 2.95
Reynoldsville.......	2.50 @ 2.75	2.75 @ 2.95
Quemahoning.......	2.65 @ 2.85	2.95 @ 3.10
Somerset County (best grades)......	2.50 @ 2.75	2.95 @ 3.10
Somerset County (poorer grades)....	2.00 @ 2.35	2.50 @ 2.75
Western Maryland..	2.25 @ 2.50	2.50 @ 2.75
Fairmont	2.00 @ 2.25	2.35 @ 2.50
Latrobe............	2.10 @ 2.25	2.25 @ 2.40
Greensburg.........	2.25 @ 2.35	2.35 @ 2.60
Westmoreland......	2.60 @ 2.75	2.60 @ 2.75
Westmoreland run-of-mine..........	2.35 @ 2.60	2.35 @ 2.65

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide		Line	Tide
Broken.....	$5.95	$7.80	Buckwheat....	$3.40	$4.45
Egg.......	6.05	7.90	Rice.........	2.75	3.65
Stove......	6.30	8.15	Boiler.......	2.50	3.50
Nut.......	6.40	8.25	Barley....	2.25	3.15
Pea........	5.00	6.60	Culm.....	1.25	2.15

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes...	$2.55@$2.75	$3.25
Mine-run......... ..	2.35@2.50	3.00
Screenings............	1.85@2.20	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam...	$2.45	$2.75	$2.40
Black Creek and Cahaba.	3.45	3.75	3.05
Jagger - Pratt Corona	2.85	3.05	2.45
Blacksmith.....	..	5.25	.....

Domestic quotations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba.. ..	3.95@$4.60
Corona ...	3.50
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

Franklin County		Mt. Olive and Staunton	Standard
Prepared sizes, lump, egg, Nos. 1 and 2 nut......	$2.75		
Williamson County			
Prepared sizes, lump, egg, nut........	$2.55	$2.55	$2.00@2.25
Mine-run	2.35	2.20	1.60@1.75
Screenings........	2.20	2.05	1.15@1.30
3-in. lump		2.30	
2-in. lump........			1.75@1.90

Williamson-Franklin rate to St. Louis is $1.07; other rates 92½c

New Construction

PROPOSED WORK

N. Y., Central Islip—The State Hospital Commission, Capitol, Albany, will soon award the contract for installing one 600 hp. boiler, 4 stokers, new coal bunker and conveyor, etc., at the Central Islip State Hospital here. Estimated cost, $200,000.

N. Y., New York—The New York Edison Co., Irving Place and 15th St., plans to build a 3 story, 45 x 75 ft. transformer station at 421-423 East 6th St. Estimated cost, $60,000. W. Whitehill, 32 Union Square, Arch.

N. Y., Oswego—The Hinckly Towing Co. will install pumps, cranes, etc., in connection with the dry-dock-marine railway which it plans to build. Total estimated cost, $100,000.

N. Y., Pierrepont Manor—The Northern New York Milk Co. recently incorporated with $500,000 capital stock will install boilers, electric power motors and an ammonia ice plant in connection with the milk station, evaporating plant and milk shipping station which it plans to build. Estimated cost, $200,000. Address F. P. Redfield, Adams, Dir.

N. Y., Potsdam—T. E. Finegan, Deputy Comr. of Education, Education Bldg., Albany, will soon award the contract for the construction of a 54 x 64 ft. boiler house, etc., at the Potsdam Normal School here. Estimated cost, $85,000. L. F. Pilcher, Capitol, Albany, State Arch.

N. Y., Rockaway—The Bureau of Yards & Docks, Navy Department, Washington D. C., plans to build an electric light and power distributing system, at the Naval Air Station here. Estimated cost, $60,000 Specification No. 3958.

N. Y., Utica—The Board of Education has authorized J. Kemper, City Engr., to receive bids for installing a new heating and air washing system in School No. 18. Estimated cost, $14,500.

N. J., Jersey City—The Eastern States Refrigerating Co., 147-16th St., plans to build a 7 story plant on Provost St. Estimated cost, $150,000.

N. J., Rahway—The city plans to build a river terminal on the Rahway River, to include cold storage warehouses, sheds, etc. Total estimated cost, $2,400,000. H. Mc. L Harding, 52 Vanderbilt Ave., New York City, Engr.

Md., Baltimore—The Standard Oil Co., Pier 2, Pratt St. plans to build an engine and pump house at Hanover and Barney St.

D. C., Washington—The Board of Commissioners, Room 511, District Bldg., will soon award the contract for the construction of a small pump house at the municipal fish market on Water St., between 11th and 12th St., Southwest.

W. Va., Huntington—J. M. McCoach Co., 7th Ave. and 13th St., will receive bids in the fall for the construction of a 4 story addition to its ice and cold storage plant, to increase the ice capacity from 120 to 225 tons daily and cold storage from 30,000 to 100,000 bbl. daily. Estimated cost, $200,000. Architect not selected.

S. C., Williston—L. S Williston, Clk., Comrs. of Pub. Wks., will soon award the contract for establishing a water works system. Plans include the construction of a deep well pumping station, etc. Estimated cost, $30,000.

Ga., Alma—The city plans to build an electric light plant. J. B. McCrary Co., 3rd National Bank Bldg., Atlanta, Engr.

Ga., Unadilla—The city plans to build an electric light plant. Estimated cost, $15,000. J. B. McCrary Co., 3rd National Bank Bldg., Atlanta, Engr.

Fla., Key West—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will soon award the contract for the construction of a power house and installing electric generator equipment and fire protection system here. Estimated cost, $105,000. Specification No. 3956 Noted May 27.

Ohio, Cleveland—The Frantz Premier Co., Ivanhoe Rd., is in the market for one second hand, 6 to 12 volts, 1000 amperes electric plating generator, also one 12-in. Hendey lathe with or without taper attachment.

Ohio, Cleveland—The Republic Motor Truck Co., Alma, Mich., has awarded the contract for the construction of a service building, gas engine plant, etc., on Babbitt Rd. here, to Westinghouse, Church & Kerr, 37 Wall St., New York City. A steam heating system will be installed in same. Total estimated cost, $10,000,000.

Mich., Kalamazoo—The Western Board & Paper Co. will install a power house for steam plant with mechanical coal conveyors, automatic stokers, etc., in connection with the 3 story, 60 x 218 ft. stock house which it plans to build

Ill., Chicago—The Anchor Leather Co., Division and Hickory St., has awarded the contract for the construction of a 3 and 1 story, 101 x 148 ft. factory, to Van Etten Bros., 143 East 111th St. A 200 h.p. high pressure boiler will be installed in same. Estimated cost, $65,000.

Ill., Columbia—The Village Clerk will soon award the contract for the construction of improvements to the electric light and power plant; to be divided in Sect. 1, building extension and machinery foundations: Sect. 2, 100 hp., H.R.T. boiler and breeching; Sect. 3, 100 ft. x 4 in. concrete chimney; Sect. 4, 120 hp. non-releasing Corliss or Unaflow engine; Sect. 5, heater, boiler, feed pump, pipe work and covering; Sect. 6, direct connected A. C. generator, exciter, transformer and switchboard. Fuller Beard, Chemical Bldg., St. Louis, Mo., Engr.

Wis., Carrollville (Otjen P. O.)—The U. S. Fertilizer Co., c/o the U. S. Glue Co. will install motors in connection with the fertilizer plant which it plans to build. Estimated cost, $100,000 H. J. Esser, Camp Bldg., Milwaukee, Engr.

Wis., Eau Claire—The city plans to improve the water works system. Plans include new well, centrifugal pump, water wheel generator at the pumping station and concrete flume. Estimated cost, $100,000. A. R. Garnock, 1000 Guardian Life Bldg., St. Paul, Minn., Engr.

Wis., Milwaukee—W. R. Callahan, Purch. Agt., of the Central Board of Purchases, City Hall, will receive bids until July 16 for furnishing one 20,000,000 gal. pumping engine at the North Point Pumping Station. Estimated cost, $250,000. G. F. Staal, City Hall, City Engr.

Minn., Austin—The Board of Education is having plans prepared by F. Tustison, Arch., 355 Auditorium Bldg., Minneapolis, for the construction of a central boiler plant and mechanical equipment for the junior and senior high school, for old and new buildings. Estimated cost, $150,000.

Minn., Austin—The State Board of Control, Capitol, St. Paul, will soon award the contract for installing a boiler and stoking plant at the municipal electric pant here C. L. Pillsbury Co., 801 Metropolitan Life Bldg., Minneapolis, Engr.

Minn., Brainerd—The city will receive bids until July 7 for improving the waterworks system. Project includes the construction of a pumping station with electrical pumping equipment, etc. Total estimated cost, $250,000. L. P. Wolff, 1001 Guardian Life Bldg., St. Paul, Consult. Engr. Noted Apr. 22.

Minn., Hastings—The State Board of Control, Capitol, St. Paul, will soon award the contract for the construction of a power plant. Estimated cost, $150,000 C. L Pillsbury, Metropolitan Life Bldg., Minneapolis, Engr. Noted May 13.

Minn., Minneapolis—The State Board of Control, Capitol, St. Paul, will soon award the contract for the construction of new generating units for the electric light plant, to include fire alarm system, refrigerating plant, etc. Estimated cost, $75,000. C. L. Pillsbury Co., 801 Metropolitan Life Bldg., Engr. Noted June 24.

Kan., Sharon Springs—The city voted $50,000 bonds for the construction of a power plant, installing one 105 and one 100 hp. engines and improving the distributing system Noted June 3.

N. D., Amenia—The Amenia & Sharon Land Co. will soon award the contract for the construction of a power house; oil engines and accessories for two 3 phase, 60 cycle, 2300 volt alternators, etc. E. D. Jackson, 601 Capital National Bank Bldg., St. Paul, Minn., Engr.

Mo., St. Louis—The Monarch Weather Strip Co., 4121 Forest Park Blvd., is in the market for several 3 hp. motors and three or four ¾ hp. motors, etc. J. A. Coellner, Supt.

Idaho, Boise—The State will install 1 or 2 water tube boilers to add to the present steam heating plant, and electrically driven centrifugal ventilating fans for double system, in connection with the addition to the State Capitol building which it plans to build on Jefferson St. Total estimated cost, $900,000. W. J. Hall, Comr. of Pub. Wks. Tourtellote & Hummell, Overland Bldg., Arch.

Ore., Florence—The city voted $2000 bonds for the construction of a light and water plant and is in the market for a Diesel engine. Address the City Marshall.

Ore., Salem—The Clackamas Power & Irrigation Co., Clackamas, has filed application with H. Nunn, State Highway Engr., for development of 11,705 hp. plant, 1000 acre-ft. of water to be taken from the Clackamas River. Plans include a 400 ft dam, 103 ft. water fall, 6.6 mi. flume and ditch. Total estimated cost, $1,250,000.

Cal., Avalon—The city voted $88,000 bonds for the construction of a combined electric light and water works plant on Catalina Island here. Noted June 17.

Cal., Coburn—Switzer & Meyemberg will install two 100 hp. steam boilers and refrigerating machinery in connection with the 2 story creamery which it plans to build. Total estimated cost, $45,000. F. R. Spangler, King City, Arch.

Cal., Fresno—A Mattei will install a steam heating plant and electric power plant in connection with the 12 story, 50 x 150 ft. office building which it plans to build on Fresno and J St. Total estimated cost, $400,000. E. Mathewson, 428 Cory Bldg., Arch.

Cal., Palo Alto—The city plans election soon to vote on $72,000 bonds for installing a Diesel engine for generating electricity for the lighting plant. J. F. Byxbee, Jr., Engr.

Cal., Visalia—The Visalia National Bank & Trust Co. will install a steam heating plant in the 4 story, 83 x 116 ft. bank and office which it plans to build on Main and Church St. Total estimated cost, $200,000. E. J. Kump, 227 Powell Bldg., Fresno, Cal., Arch.

CONTRACTS AWARDED

Mass., Boston—The Commissioner of Public Works received bids for installing condensers at the Calf Island Pumping Station here, from the Schumaker Santry Co., 141 Milk St., $10,334; Power Equipment Co., 131 State St., $10,800.

Mass., Boston—The School Commission received bids for installing a heating plant in the Gibson School, from J. J. Hurley, $13,952; F. W. Zemier, 154 Pearl St., $14,367; J. P. Dwyer, 183 Harrison Ave., $14,700. J. P. Lomasney, City Hall, Chn. Schoolhouse Comm.

Mass., Chelsea—The Bureau of Yards & Docks, Navy Department, Washington, D. C., received bids for extending the heating plant and distribution system here, work complete, from the Power Efficiency Corp., White Bldg., Buffalo, N. Y., $54,886; Lynch & Woodward, 287 Atlantic Ave., Boston, Mass., $57,432; Lord Construction Co., 112 Water St., Boston, Mass., $59,927. Specification No. 3891.

Conn., New Haven—The Seamless Rubber Co., 534 Congress Ave., has awarded the contract for the construction of a plant on Hallock Ave., to the Aberthaw Construction Co., 27 School St., Boston, Mass Plans include the construction of a large power house. Total estimated cost, $500,000.

N. Y., Central Islip—The State Hospital Commission has awarded the contract for installing a heating plant at the Central Islip State Hospital here, to W. B. Armstrong Co., 3 Fulton St., Albany. Estimated cost, $22,842. Noted May 27.

N. J., Bayonne—The city received bids for furnishing 2 high powered contrifugal pumps to increase the water pressure throughout the city from the Buffalo Steam Pump Co., 39 Cortlandt St., New York City (no definite figure, but asked to submit estimate later); Dugan Forest Engineering Co., Motor driven pump on concrete foundation provided by the city, $9520; Worthington Pump Co., 115 Broadway, New York City, $8700; J. R. Proctor, Inc., 721 Broadway, Bayonne. 7 styles ranging in price from $7191 to $10,093.

Penn., Philadelphia—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for installing a heating and humidifying and Dew Point control system at the Aircraft Storage Building here, to the Enterprise Steam & Hot Water Heating Co., 600 North Howard St., Baltimore, Md., $62,529. Noted May 27.

Md., Highlandtown (Baltimore P. O.)—Jones & Lamb Co., Pennsylvania and Fulton Ave., Baltimore, has awarded the contract for remodeling the Monumental Brewery plant into a meat packing plant, oil refinery and ice plant, to the Consolidated Engineering Co., 243 Calvert Bldg., Baltimore. Estimated cost, $250,000. Noted April 29.

Ohio, Cincinnati—The Treasury Department, Superv. Archt's. office, received bid for installing boiler here, from the Heine Safety Boiler Co., 5319 Marcus St., St. Louis, Mo. $39,930, (195 days).

Business Opportunities
Equipment Bargains
Wants
Jobs
Men

Men
Jobs
Wants

Business Opportunities
Equipment Bargains
Wants
Jobs
Men

Equipment Bargains
Business Opportunities

all the worth-while "Opportunities" of the power plant field. You will find them in the

SEARCHLIGHT SECTION

SEE PAGES 92 *TO* 102.

PRICES - MATERIALS - SUPPLIES

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE

	Fire	50-Ft. Lengths
Underwriters' 2½-in		70c per ft.
Common, 2½-in		40–10%

Air

	First Grade	Second Grade	Third Grade
¾-in. per ft	$0.45	$0.30	$0.20

Steam—Discounts from List

First grade. 35% Second grade.... 45% Third grade.... 50%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	65%	Best grade	40%
Standard	50–10%		

Note—Above discounts apply on new list issued July 1.

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	45%	35%
St Louis	45%	35%
Chicago	45%	40%
Birmingham	35%	35%
Denver	35–5%	30%

RAWHIDE LACING—20% for cut; 45c. per sq. ft. for ordinary.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0 90
Asbestos for high-pressure steam	1 60
Duck and rubber for piston packing	1 00
Flax, regular	1.20
Flax, waterproofed	1 60
Compressed asbestos sheet	1 00
Wire insertion asbestos sheet	1 20
Rubber sheet	.60
Rubber sheet, wire insertion	80
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1 20
Asbestos wick, ½- and 1-lb. balls	85

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0 27	½-in.	$0 27
2-in.	36	1 -in.	.30
6-in.	80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	75
8-in.	1 10	3 -in	.90
10-in.	1.30	3½-in.	1 05

85% magnesia high pressure		List
For low-pressure heating and return lines	4-ply	58% off
	3-ply	60% off
	2-ply	62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Pittsburgh	Chicago	St Louis	Birmingham	Denver
Cup	7	9	5¼	7	8½	14½
Fiber or sponge	8	10	6	13	8½	18
Transmission	7	9	6	13	8½	20
Axle	4½	6	4	4 75	4	5¼
Gear	4½	9	4½	7.5	8½	8
Car journal	22(gal.)	21 (gal.)	3½	4 9	8½	8

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Current	One Year Ago		
White	11 00 to 13 00	13 00	14 00	11 00 to 14 00
Colored mixed	8 50 to 12 00	12 00	11 00	9.50 to 12.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13½ x 13½	13½ x 20½
Cleveland	$52 00	$58.00
Chicago	41 00	43 50

LINSEED OIL—These prices are per gallon:

	New York		Cleveland	Chicago		St.Louis
	Current	One Year Ago	Current	Current	One Year Ago	Current
Raw in barrels	$1 93	$1.61	$2.00	$2.10	$1.66	$1 69
5-gal. cans	2.06	1.71	2.25	2.30	1.86	1.75

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	13 00	14 50	11 25	11.50	13 00	10 50
25- and 50-lb. kegs	13 25	14 75	11 50	11 75	13 25	10 75
12½-lb. keg	13 50	15 00	11.75	11 00	13 50	11 00
1-lb. cans	15 00	16.50	13 25	13 00	15 00	13 00
5-lb. cans	16 00	17 50	13.25	13 50	16 00	13 00

500 lb. lots less 10% discount; 2000 lb. lots less 10–2½%.

AMMONIA—Price per pound in St. Louis for 26 deg. U. S. P., 100-lb. carboys, is 8½c.; in 1000-lb. drums, 7c.

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel 7/16 and smaller	65%	60–5%	45%
Tinned	65%	60–5%	40%

Boiler rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York. .$6 35 Cleveland...$4.00 Chicago.. $4.87 Pittsburgh...$4.65

Structural rivets, same sizes:

New York. . $6 25 Cleveland. $4.10 Chicago . $4.97 Pittsburgh...$4 75

REFRACTORIES—Following prices are f. o. b. works, Pittsburgh:

Chrome brick	net ton	$120.00	at Chester, Penn.
Chrome cement	net ton	65.00	at Chester, Penn.
Clay brick, 1st quality fireclay	net ton	40–30	at Clearfield, Penn.
Clay brick, 2nd quality	net ton	38–48	at Clearfield, Penn.
Magnesite, dead burned	net ton	32.50	at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80–90	at Chester, Penn.
Silica brick	net ton	45–55	at Mt. Union, Penn.

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—Fire Clay, $30 to $40.

Birmingham—Fire clay, $41–$44; silica, $46, $50-$15.50 magnesite, $80-$85; chrome, $80-$90.

Chicago—Second quality, $25 per ton.

Denver—Silica, $35 per 1000.

FUEL OIL—Domestic light, 22-26 deg., Baume, is 8½c. per gal. in St. Louis.

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	87 00	125 00	79.00	100 00	75.00	113.00
Commercial	42 00	70 00	18 50	22 00	15 00	23 00

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$25.50–30	$15 00
Cleveland	20 00	15 00
Chicago	16.50	15 00

In coils an advance of 50c. usually is charged.

Domestic iron (Swedish analysis) is selling at 15c. per lb.

POLES—Prices on Western red cedar poles:

	New York	Chicago	Denver	San Francisco
6 in. by 30 ft	$5 82	$5.17	$4 55	$5.17
7 in. by 30 ft	7 65	6 85	6.10	6.85
7 in. by 35 ft	11.10	10 00	8 95	10 00
8 in. by 35 ft	12 65	11 35	10.10	11 35
7 in. by 40 ft	12 85	11 50	10 20	11 50
8 in. by 45 ft	18.90	16 90	15 00	16 90
8 in. by 50 ft	22.65	20 30	18 00	20 30

10c. higher freight rates on account of double loads.

For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft	$9 00
12-in. butts, 6-in. tops, length 30-40 ft	11 50
12-in. butts, 6-in. tops, length 41-50 ft	12 50
14-in. butts, 6-in. tops, length 51-60 ft	21 00
14-in. butts, 6-in. tops, length 61-71 ft	23 50

PIPE—The following discounts are for carload lots f. o. b. Pittsburgh; basing card of Jan. 1, 1919, for steel pipe and for iron pipe:

	Steel			Iron	
Inches	Black	Galvanized	Inches	Black	Galvanized
BUTT WELD					
⅛, ¼, and ⅜	50½%	24%	¾ to 1½	39½%	23½%
½	54½%	40%			
¾ to 3	57½%	44%			
LAP WELD					
2	50½%	38%	2	32½%	18½%
2½ to 6	53½%	41%	2½ to 6	34½%	21½%
BUTT WELD, EXTRA STRONG PLAIN ENDS					
⅛, ¼ and ⅜	46½%	29%	¾ to 1½	39½%	24½%
½	51½%	39%			
¾ to 1½	55½%	43%			
LAP WELD, EXTRA STRONG PLAIN ENDS					
2	48%	37½%	2	33½%	20½%
2½ to 4	51%	40½%	2½ to 4	35½%	23½%
4½ to 6	50%	39½%	4½ to 6	34½%	22½%

Stock discounts in cities named are as follows:

	New York		Cleveland		Chicago	
	Black	Galvanized	Black	Galvanized	Black	Galvanized
¾ to 3 in. steel butt welded	47%	31%	46½%	31 %	57½%	44%
2½ to 3 in. steel lap welded	42%	27%	42½%	27½%	51½%	41%

Malleable fittings. Class B and C, from New York stock sell at list + 12½%. Cast iron, standard sizes, 10% off.

BOILER TUBES—The following are the prices for carload lots, f. o. b. Pittsburgh:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in	40½	3½ to 4½ in	15½
2½ to 3¼ in	30½	3 to 3¼ in	1
2¼ in	24	2½ to 2¾ in	+ 1
1¾ to 2 in	19½	2 to 2¼ in	+16
		1¾ to 1⅞ in	+29

Standard Commercial Seamless—Cold Drawn or Hot Rolled

	Per Net Ton		Per Net Ton
1 in	$327	1¾ in	$207
1¼ in	267	2 to 2½ in	177
1⅜ in	257	2¾ to 3¾ in	167
1½ in	207	4 in	187
		4½ to 5 in	207

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation

ELECTRICAL SUPPLIES

ARMORED CABLE—

B.&S. Size	Two Cond. M Ft.	Three Cond M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$104 00	$138 00	$164 00	$210.00
No. 12 solid	135 00	170 00	225.00	265.00
No. 10 solid	185 00	235.00	275 00	325.00
No. 8 stranded	285.00	375 00	520 00	500.00
No. 6 stranded	400.00	500 00	560.00	

From the above lists discounts are:

Less than coil lots	Net List
Coils to 1,000 ft.	10%
1,000 ft. and over	15%

BATTERIES, DRY—Regular No. 6 size red seal, Columbia, or Ever Ready

	Each, Net
Less than 12	$0 40
12 to 50	38
50 to 125 (bbl.)	.35
125 (bbl.) or over	.32

CONDUITS ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per 100 for couplings and elbows:

	Conduit		Elbows		Couplings	
Size, In	Black 1,000 Ft. and Over	Galvanized 1,000 Ft. and Over	Black 100 and Over	Galvanized 100 and Over	Black 100 and Over	Galvanized 100 and Over
⅜	$71 15	$76.25	$17.04	$18.18	$5 38	$5.74
½	71 15	76.25	17 04	18 18	6 28	6 70
¾	93 96	100.86	22.43	23.93	8 97	9 57
1	138 39	149 09	33.19	35.41	11 66	12 44
1¼	187 91	201 71	42.62	45.31	16.10	17.12
1½	224 68	241 18	56.82	60.62	19.89	21.15
2	302 29	324 49	104.17	110 77	26 52	28 20
2½	477 95	513 05	170.46	181 26	37 88	40.28
3	625 00	670.91	454.56	483 36	56.82	60 42
3½	779 24	834.44	1,003.82	1,067.42	75 76	80 56
4	945.03	1,010.43	1,160.08	1,233.57	94.70	100.70

5% cash 10 days.

From New York Warehouse—Less 5% cash

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.	
7/32	250	$0.05½	Coils . . 55% off Less coils, 45% off
¼	250	.06	
⅜	250	.09	
½	200	.12	
⅝	200	.15	
¾	150	.18	
1	100	.25	
1¼	100	.33	
1½	Odd lengths	.40	
2	Odd lengths	.55	

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0 11	T. P. to D. P. S. B.	$0 24
D. P. M. L.	18	T. P. to D. P. T. B.	38
T. P. M. L.	26	T. P. S. B.	.33
D. P. S. B.	19	T. P. D. B.	.54
D. P. D. B.	37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0 33	$0 84	$1.68
T. P. M. L.	48	1 20	2.40
D. P. S. B.	42	1 05	
T. P. S. B.	81	1 80	
D. P. D. B.	78	2 10	
T. P. D. B.	1 35	3 60	
T. P. to D. P. D. B.	90	2 52	

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$16.75
No. 16 cotton twisted	22.00
No. 18 cotton parallel	19.80
No. 16 cotton parallel	25.75
No. 18 cotton reinforced heavy	30.00
No. 16 cotton reinforced heavy	36.50
No. 18 cotton reinforced light	23.40
No. 16 cotton reinforced light	27.50
No. 18 cotton Canvasite cord	26.00
No. 16 cotton Canvasite cord	28.50

FUSES, ENCLOSED—

250-Volt.	Std. Pkg.	List
3-amp. to 30-amp	100	$0.25
35-amp. to 60-amp	100	35
65-amp. to 100-amp	50	90
10-amp. to 200-amp	25	2.00
15-amp. to 400-amp	25	3.60
2-amp to 600-amp	10	5 50

600-Volt	Std. Pkg.	List
3-amp. to 30-amp	100	.40
35-amp. to 60-amp	100	.60
65-amp. to 100-amp	50	1.50
110-amp. to 200-amp.	25	2.50
225-amp. to 400-amp	25	5.50
450-amp. to 600-amp.	10	8 00

Discount: Less 1-5th standard package	30%
1-5th to standard package	40%
Standard package	52%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package	$4.75 C
0-30 ampere, less than standard package	6.00 C

LAMPS—Below are present quotations in less than standard package quantities.

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B— Watts	Plain	Frosted	No. in Package	Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.35	$0 38	100	75	$0 70	$0 75	50
15	35	38	100	100	1 10	1.15	24
25	35	38	100	150	1 65	1 70	24
40	.35	.38	100	200	2 20	2 27	24
50	35	38	100	300	3 25	3 35	24
60	40	45	100	400	4 30	4 45	12
100	.85	92	24	500	4 70	4 85	12
				750	6 50	6 75	8
				1000	7.50	7 75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list

PLUGS, ATTACHMENT—

		Each
Hubbell, porcelain No. 5406,	standard package 250	$0 24
Hubbell composition No. 5467,	standard package 50	32
Benjamin swivel No. 903,	standard package 250	.20
Hubbell current taps No. 5638,	standard package 50	40

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$12 00	$14 00	$13 90	$25 00
12	13 25	15 70	18 05	30 70
10	18 30	21 00	23 85	41 50
8	25 54	28 60	32 70	56.77
6	..	.	51 40	
4	.	......	70 00	..
2	..	....	101 80	...
1	..	....	131 86	.
0	..	......	160 00	...
00	...	...	193 50	.
000	..	..	235 20	
0000	.		288 60	.

Prices per 1000 ft. for Rubber-covered Wire in Following Cities:

	Denver			St. Louis			Birmingham*		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$15 00	$16 00	$34.00	$16 00	$21 00	$33 00	$9.92	$15.25	$27.75
10	17 65	24 25	48.00	27 20	31 00	69 00	20 25	24.25	46.90
8	24 50	31 75	66.00	38 00	42 00	78 00	27 60	32.60	.
6	38 65	42 25			65 00	130 00	48 25	54.75	..
4	54 35	58 95	.		93 00		66 90	73.75	
2	80.85	86 15			140 00		96.00	104.50	
1	100.05	113.10	...	..	182 00		121.00	136.40	
0	.....	158.00	.	.	242 00		169.00	174.60	
00	.	183.60	.	.	290 00		203.50	214.00	
000	.	222.80	.	.	360 00		246.00	257.50	
0000	.	269.70			435 00	...	295.50	308 50	

Pittsburg—23c. base; discount 50% *June 1st prices.

SOCKETS, BRASS SHELL—

¼ In. or Pendant Cap.			⅜ In. Cap		
Key, Each	Keyless, Each	Pull, Each	Key, Each	Keyless, Each	Pull, Each
$0 33	$0 30	$0 60	$0 39	$0.36	$0 66

Less 1-5th standard package	+20%
1-5th to standard package	+10%
Standard package	−15%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B.&S. regular spools (approx 8 lb.)	36c. lb.
No. 18 B.&S. regular 1-lb. coils	37c. lb.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 50c. lb., 100 lb. lots	48c. lb.
Rubber tape, ¾ in., less 100 lb., 65c. lb., 100 lb. lots	60c. lb.
Wire solder, less 100 lb. 50c. lb., 100 lb. lots	46c. lb.
Soldering paste, 2 oz. cans Nokorode	$1 20 doz.

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$0 42	$0 68	$1 02	$1.36
60	74	1 22	1 84	2 44
100	1 50	2 50	3 76	5 00
200	2 70	4 50	6 76	9 00

TYPE "C" FUSIBLE, TOP OR BOTTOM

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole Each
30	70	1.06	1.60	2 120
60	1 18	1 80	2.70	3.60
100	2 38	3 66	5 50	7.3
200	4 40	6 76	10 14	13.50

Discounts:

Less than $10.00 list value	+ 5%
$10 to $25 list value	— 8%
$25 to $50 list value	—15%
$50 to $200 list value	—20%
$200 list value or over	—25%

er 2

BOILE
Pittsbu

ARMO

No. 14
No. 12
No. 10

BATT

CONI

CUT-

FLEX

FUSI

RESUSCITATION FRO

By the Prone P

National Elec

Note—This chart is an abb
tation from Electrical Sh
Electric Light Association

Follow These Instructions Even if Victim Appears Dead

I. FREE THE VICTIM FROM THE CIRCUIT IMMEDIATELY

Quickly **release** victim from current, being careful to **avoid** receiving **a** shock. Use any **dry non-conductor** (rubber gloves, clothing, rope, board) to move either the victim or the conductor. Beware of using metal or any moist material. If necessary, **shut off the current.**

II. INSTANTLY ATTEND TO THE VICTIM'S BREATHING

1. As soon as the victim is clear of the conductor rapidly feel with your finger **in his mouth** and throat and remove any foreign body (tobacco, false teeth, etc.). If mouth is **tight shut, pay no more attention to it until later.** Do not stop to loosen the patient's clothing, but **immediately begin actual** resuscitation. **Every moment of delay is serious.** Proceed as follows:

(a) Lay the **patient on his belly,** one **arm** directly **extended** overhead, the other bent at elbow and with **face to one side,** resting on the hand or forearm, so that nose and mouth are free for breathing (see Fig. 1).

(b) **Kneel straddling the patient's hips** with knees just below the patient's hip bones or opening of pants pockets; place the **palms** of your hands **on the small of the back,** with fingers spread over the lowest ribs, the **little finger** just **touching** the **lowest rib,** the thumb alongside of your fingers; tips of fingers just out of your sight, as in Fig. 1.

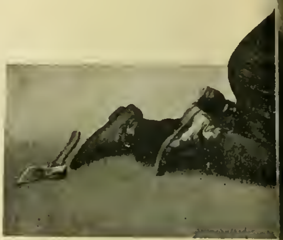
(c) While counting one, two, and with **arms** held **straight, swing forward** slowly so that the weight of your body is gradually, but **not violently** brought to bear upon the patient. (See Fig. 2.) This act should take from two to three seconds.

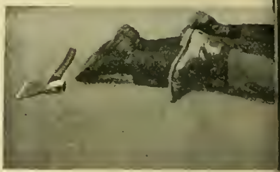
(d) While counting three, immediately **swing backward** so as to remove the pressure, thus returning to the position shown in Fig. 3.

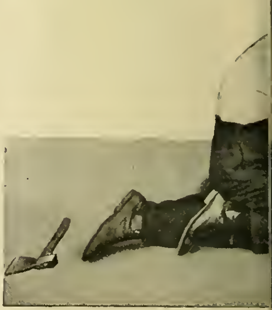
(e) While counting four, five—**rest.**

(f) **Repeat deliberately** twelve to fifteen times a minute the swinging forward and backward—a complete respiration in four or five seconds. **Time with your breathing.**

(g) As soon as this artificial respiration has been started, and while it is being continued, an **assistant** should **loosen** any **tight clothing** about the patient's neck, chest or waist. **Keep patient warm.**







Do not stop or interrupt resuscitation until patier

SUPPLEMENT T

ELECTRICAL SHOCK

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ties Building, New York.

Fig. 1

Fig. 2

Fig. 3

2. **Continue resuscitation** (if necessary **four hours or longer**) **without interruption,** until natural breathing is restored, or until a physician declares rigor mortis (stiffening of the body) has set in. If natural breathing stops after being restored, use resuscitation again.

3. **Do not give any liquid by mouth until the patient is fully conscious.** Place **ammonia** near the nose, determining safe distance by first trying how near it may be held to your own. **Assistant should hit patient's shoe heels** about **twenty (20)** times with a stick or something similar and repeat this operation every five minutes until breathing commences.

4. **Give the patient fresh air,** but keep him warm. When patient revives **keep him lying down** and **do not raise him.** If doctor has not arrived, give patient one teaspoonful of aromatic spirits of ammonia in a small glass of water if he can swallow.

5. Carry on **resuscitation at closest possible point to the accident. Do not move patient** until he is breathing normally without assistance. If absolutely necessary to move, he should be placed on a hard surface, such as a door or floor of conveyance. **Do not stop or interrupt resuscitation for an instant.**

III. SEND FOR DOCTOR

If alone with victim, **do not neglect immediate and continued resuscitation** in order to call a doctor; start at once, the first few minutes are valuable. If other persons are present, send one of them for a doctor without a moment's delay.

An up-to-date list of doctors, with telephone numbers is posted close to this chart.

The prone pressure method of artificial respiration described in rules (Section II) is equally applicable to resuscitation from electrical shock as well as all cases of suspended respiration due to drowning, inhalation of gas, smoke or fumes or to other causes.

s or rigor mortis (stiffening of the body) sets in.

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POWER

Volume 50 New York, July 8, 1919 Number 2

To the Passing G. M.

BY JAMES T. BEARD, JR.

I am talking to you, Mr. Manager Man;
I have things on my mind; that is why I began.
Just give me my say—and then give me the can
If you want to.

In the big world of business you're called a success
And your factories cover the world, more or less.
Well, my hat's off to you, in a way, for I guess
You deserve it.

I have seen your big works up the river a way;
It's an up-to-date place, but it's truthful to say
That you're losing real dough on that plant every day
That it's running.

You are proud of your plant? I don't blame you a bit.
With the latest equipment and everything fit
You have made the mill pay and you've made quite a hit
With the bosses.

But you're proud of yourself, and that sticks in my crop,
For you're wasting real money by failing to stop
Up the leaks in your steam plant and all through your shop
Up the river.

One-fourth of the coal that you burned up last week
Was just wasted—yes, wasted—by many a leak
And it might quite as well have been dumped in the creek
Or the river.

Now, although you are clever at passing the buck
To the coal or the men, you are down on your luck.
When it comes to excuses you're just a lame duck,
And you know it.

I have worked with your men and I'm ready to say
They're the humanest men with the humanest way;
They will do what you tell them, for you hold their pay
And they know it.

So it's right up to you—I am telling you straight—
For the trouble is not with the coal or the grate;
But the trouble's with you; you are 'way out of date.
Do you get me?

You are wasting our coal; you are not playing fair.
It's the country's resources, marked "Handle with Care;"
And you charge up your waste in the cost of your ware,
And we pay it.

You have laughed to yourself that we're suckers and boobs.
What you lost on your steam we have paid for, like rubes,
And we pay for the scale on your boilers and tubes.
We've been easy.

Mr. Manager Man, you are gumming your game;
We are wise to you now and we know you by name;
You have outlived your day; you have outlived your fame.
You are done for.

That man right behind you is taking your place;
He's alive to the problems that he has to face;
He is fully equipped for the gruelling race
Of the future.

It's the edict of fate, Mr. Manager Man,
That the fittest survive and that you get the can.
And you knew the sad fact long before I began.
Now I'm finished.

Remodeling SUCTION GAS MAINS Anheuser-Busch Brewery

By Robert H. Karl, M.E.

The refrigerating system at the great Anheuser-Busch brewery, which occupies seventy city blocks in St. Louis, had a rapid growth. Soon the multiplicity of ammonia-compressor piping demanded remodeling it so as to provide mains to facilitate operation and to effect greater economy especially by better insulating the piping. It was an interesting job, and Mr. Karl, the engineer, tells how it was done.

ABOUT four years ago it became evident that something had to be done with the ammonia suction-pipe system at our Ninth Street refrigerating plant. All return gas-pipe mains were very old and in bad condition, and a large increase in the refrigeration load was contemplated, which made radical changes imperative. The first refrigerating machines were installed in 1882, this being one of the first concerns in the country to utilize refrigerating machines on a large scale. The original installation was brine circulation. About 1890 more refrigerated space was added, the brine system discarded and direct expansion installed. From that time to the present the plant grew very rapidly, and additional refrigerating machines were installed from time to time as they were required, until it became one of the largest refrigerating plants in the country, having a capacity of 2000 tons and serving 10,000,000 cu.ft. refrigerated space.

This of course involved many changes, and it was apparent from the mass of return gas-pipe mains from the various stockhouses, etc., to the refrigerating machines, that no very serious attention was given to obtain an efficient pipe layout. Whenever additional stockhouses were added or machines installed, pipe connections were evidently made where most convenient, with the result that it finally became the worst-jumbled mass of pipework to be found anywhere.

This resulted in serious losses. Only a small part of the pipework was insulated, and that was in poor condition. The sizes of the mains were entirely too small for the load, which resulted in very high gas velocities, from 9000 to 12,000 ft. per min., which caused serious drops in pressure, etc.

CAUSE OF GREATEST LOSSES

The most important losses were caused by the fact that the entire work had to be done at a low pressure and temperature, while the largest portion of the load is high suction-pressure work. The reason for this is that in connection with the brewery, there is a 150-ton ice plant which operates, normally, at 15 lb. suction pressure in the ice-freezing tanks, and all stockhouse work, which is all high-temperature work varying from 31 deg. F. to 40 deg. F., which should have been done with high evaporating pressures. Because all the suction mains were connected together and operated under one pressure and temperature, 15 lb. and 0 deg. F., any attempt to operate at a higher suction pressure in the stockhouses would result in the high-pressure suction gas from the stockhouses, etc., backing up into the ice-tank suction pipes and into the ice-tank coils, which of course would cause an increase in temperature in the ice-tank coils, seriously interfering with the capacities of the ice tanks, so much so that it was impossible to get anywhere near the tonnage that should have been obtained from the ice tanks, considering the coil and can surface.

Another serious cause of trouble and loss was that it was very difficult to keep liquid from the compressors, especially when the beer coolers were working, and in order to avoid this as much as possible, this work also had to be done at low pressure. There was also a serious shortage of liquid-ammonia storage capacity, which would cause the compressors to have to handle highly superheated gas at times, which also entailed

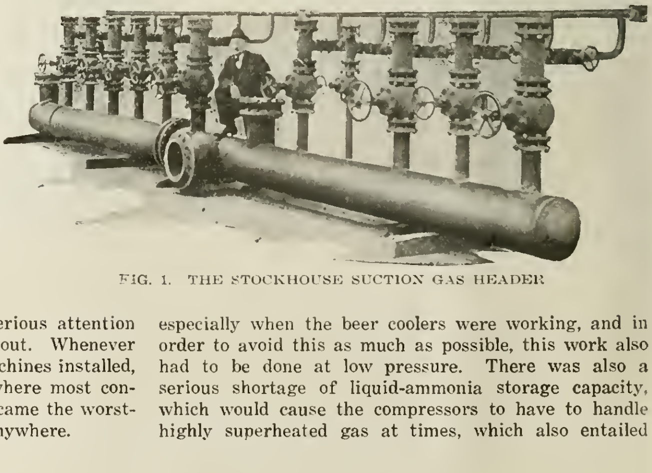


FIG. 1. THE STOCKHOUSE SUCTION GAS HEADER

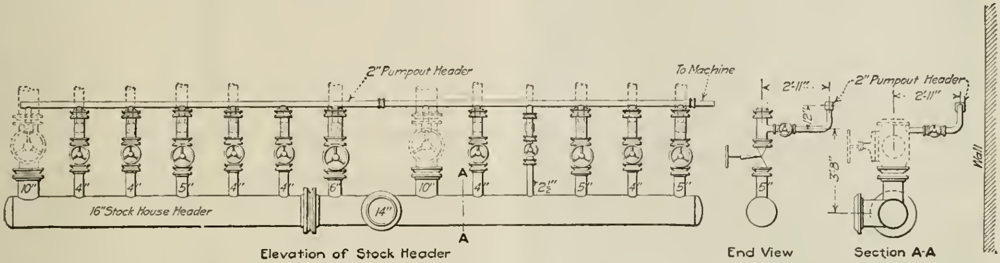
losses, and the sum total of all losses was staggering, particularly so in such a large plant.

With all of the foregoing in mind, the writer took the problem under consideration, and after some careful study of conditions, designed and installed what is without question the largest, best-designed and constructed ammonia suction gas-main system ever erected.

Contracts for all the material were placed early in the summer of 1916, so that everything would be on hand to start work in the fall as soon as weather and load conditions would permit, as it was absolutely necessary that all these changes be made without interfering with the operation of the plant in any way.

The refrigerating plant consists of seven ammonia compressors ranging in size from 175 to 500 tons, totaling 2000 tons capacity. Two of these compressors were selected to handle the winter load and with some slight temporary suction-pipe connections, we were able to take care of any load conditions that might arise, while the old suction-pipe system was removed and the new mains installed.

The new 16-in. stockhouse header was first erected against a stockhouse wall directly opposite the engine room into which we were to connect the suction pipes from the various stockhouses, beer coolers, etc. There were eleven of these connections, varying in size from 3 in. to 10 in. Provisions were also made in the header leaving two 10-in. connections with blank flanges for any future connections that might be necessary. This header is shown in Figs. 1 and 2.



Elevation of Stock Header

End View

Section A-A

FIG. 2. ELEVATIONS OF THE 16-IN. STOCKHOUSE HEADER

This 16-in. header is 32 ft. long and all nipples are welded (oxyacetylene) with a 14-in. outlet to the engine room across the alley. This 14-in. main does away with a dozen or more separate suction-pipe lines that formerly crossed the alley at this point into the compressor room. Attention is directed to the 2-in. welded header just above the main stop valves, which is the pump-out header, which allows pumping out any stockhouse without interfering with any other.

All ammonia gas from stockhouses, cellars, beer coolers, etc., enters the 16-in. header, passes through the 14-in. main into the two 48-in. diameter by 10-ft. high

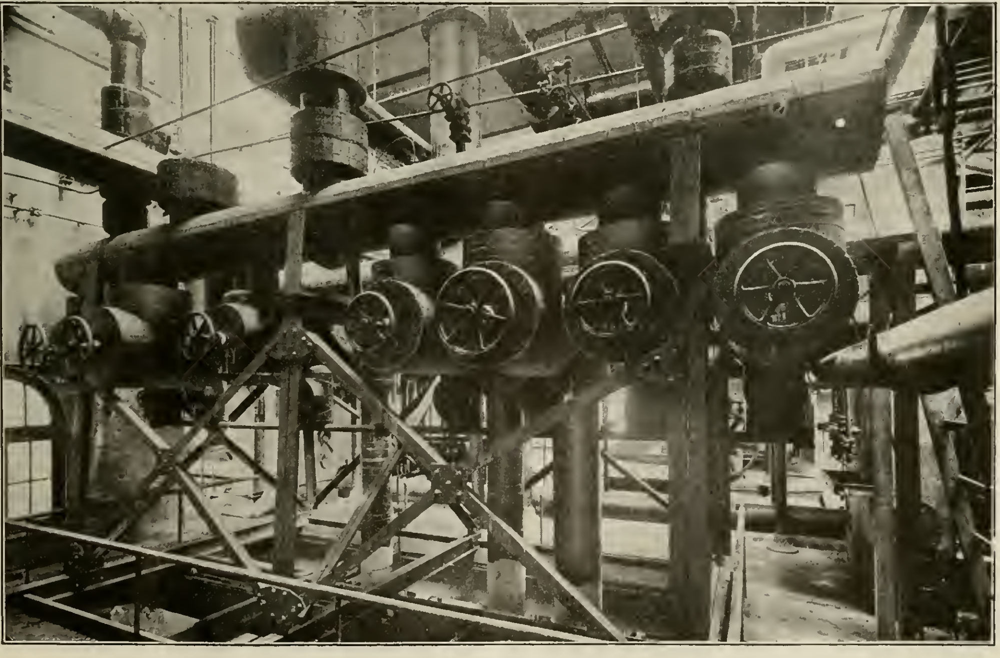


FIG. 3. THE SUCTION-GAS MACHINE HEADER IN PLACE AND PARTLY COVERED

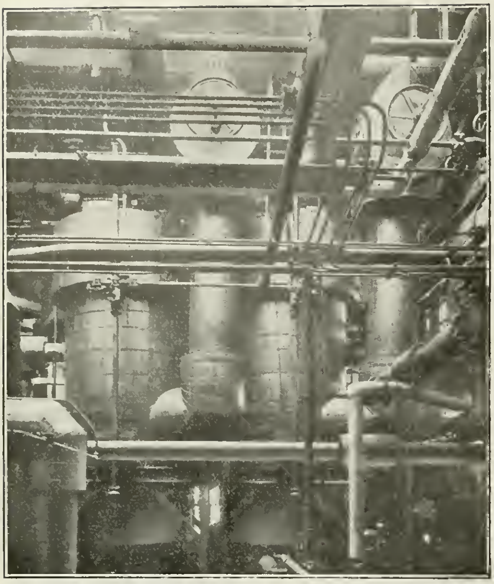


FIG. 4. THE 40-IN. BY 10-FT. LIQUID TRAPS

liquid traps located on the condenser floor above the compressors. These traps are all provided with welded 14-in. inlet and outlet connections and are also bypassed, in case it should be necessary, for any reason, to cut the traps out. (See Figs. 4, 5 and 13.)

These liquid traps are each provided with two concentric spiral coils made up of 2-in. extra-heavy pipe with a total of 1600 ft. of pipe. All liquid ammonia from the condensers passes through these coils, where it is cooled before it enters the liquid-storage tanks, by liquid carried over with the suction gas from the stockhouses and beer coolers. The traps are provided with liquid feed valves directly into the body of the traps, so in case there is not enough entrained liquid in the cold gas, the hot liquid from the condensers will heat the cold gas above a desired temperature; with this liquid feed valve, the degree of superheat is directly under the control of the operator. It has been found seldom necessary to use the liquid feed.

In case the cold gases carry more entrained liquid than the heat of liquid ammonia from the condensers can evaporate, this extra liquid is allowed to accumulate in the trap and is taken care of by two steam-driven liquid pumps of the ported suction type, which will absolutely pump anhydrous liquid ammonia, taking its suction at 15 to 30 lb., and discharging anhydrous liquid ammonia at 240 lb. Connected to the liquid traps are cylinders 20 in. in diameter and 28 in. long, all welded; each of these traps is provided with a steel float and stuffing-boxes. These floats are connected with the steam valve on the liquid pumps so that the pumps will start and stop with the level of the liquid.

All condenser-liquid headers into the traps are welded and bypassed.

The suction gas after passing through the liquid traps passes on to the compressor headers located on the same floor, which form one of the prominent features of the system.

The compressor headers are made up of a 12-in. and 14-in. wrought-iron pipe 20 ft., 4 in. long, all nipples welded in and cross-connected as shown, with angle valves and connections taken from the center of the cross-connections for the various machines on the floor below. (See Figs. 3, 8, 10 and 12.)

The 14-in. header takes care of all high-pressure suction gas from stockhouses, etc., also distilled-water coolers, and the 12-in. header provides for the low-pressure gas from the ice tanks and ice-storage and brine coolers, for which a separate main is provided. In this manner and with the headers cross-connected, any compressor can work on either high- or low-pressure gas according to the load conditions, and it also provides an independent suction-pipe system for the high- and low-pressure ammonia gas combined into one system of pipework.

The machine headers and the suction pipes to the various machines are all provided with 2-in. pump-out connections; in fact, there is a complete independent pump-out pipe system, which connects all different parts which go to make up the suction-pipe system, also all the high-pressure side, all connected to a small ammonia compressor installed expressly for the purpose of pumping out any compressor or any part of the entire system without interfering with any part of the plant. This has proved a valuable feature.

In making the suction-pipe connections from these headers to the compressors, the pipe sizes were all made

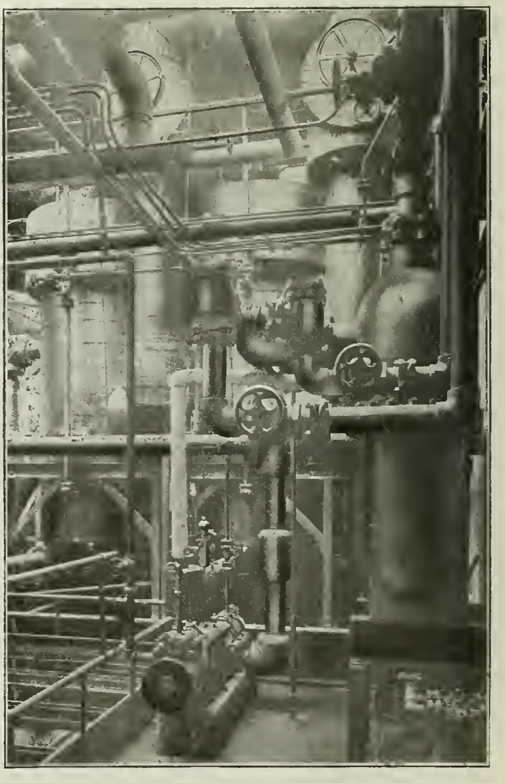


FIG. 5. SHOWING THE LIQUID PUMP FOR THE 40-IN. BY 10-FT. LIQUID TRAPS

considerably larger than the present machines called for; this provision was made because most of our compressors are of the older type with smaller suction pipes than are called for by the more modern compressors, and it is the intention, at some later date, to install more modern compressors calling for larger suction pipes, and by making this provision now, this suction-pipe system will not have to be changed to make the necessary provisions. In fact, the whole system of suction pipework was designed with a view of taking care of considerable more load at any future time.

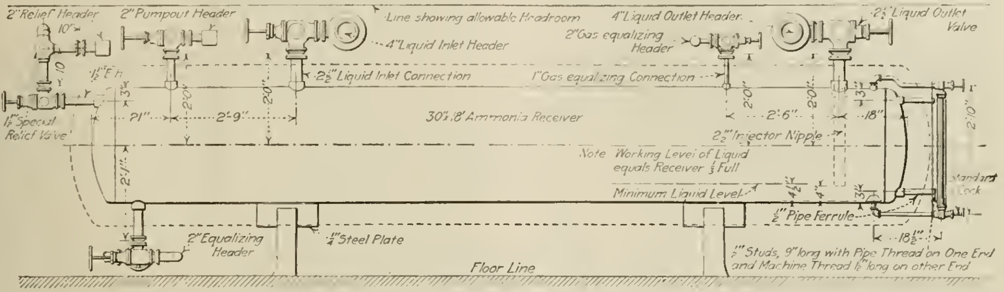


FIG. 6. ONE OF THE THREE 30-IN. BY 18-FT. WELDED AMMONIA RECEIVERS, SHOWING ALL CONNECTIONS

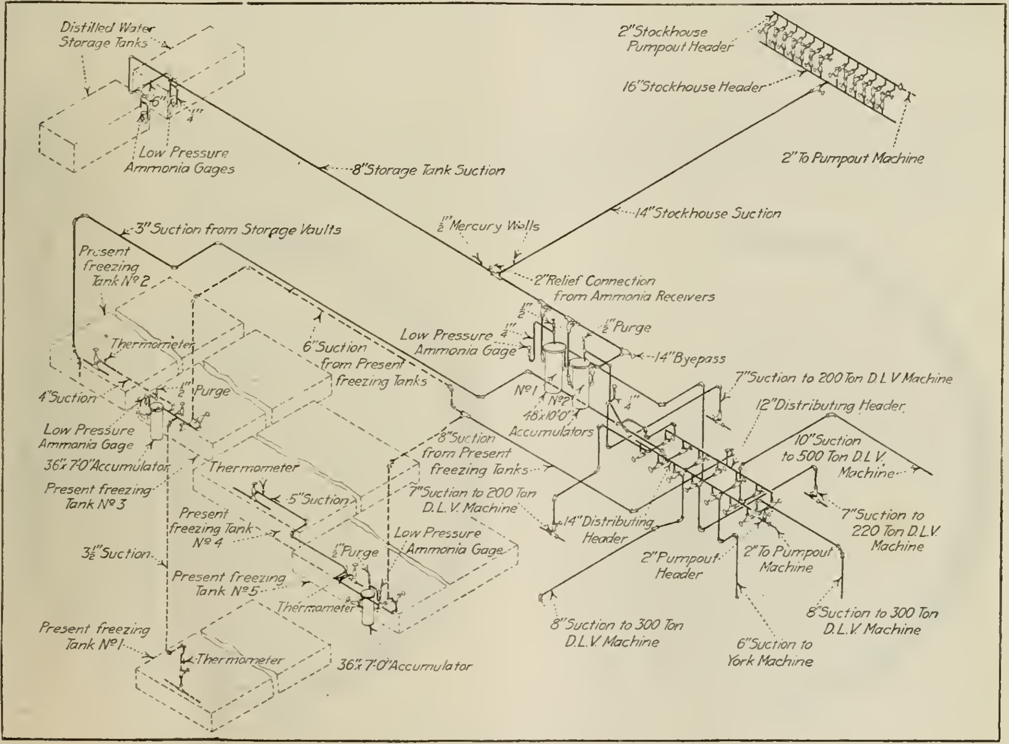

Distilled Water Storage Tanks
6"
¼"
Low Pressure Ammonia Gages
8" Storage Tank Suction
2" Stockhouse Pumpout Header
16" Stockhouse Header
2" To Pumpout Machine
14" Stockhouse Suction
½" Mercury Wells
2" Relief Connection from Ammonia Receivers
3" Suction from Storage Vaults
Present freezing Tank No 2
Thermometer
6" Suction from Present freezing Tanks
½"
¼"
Low Pressure Ammonia Gage
½" Purge
14" Byepass
No 1
No 2
48"x10'0" Accumulators
¼"
7" Suction to 200 Ton D.L.V. Machine
12" Distributing Header
10" Suction to 500 Ton D.L.V. Machine
4" Suction
½" Purge
Low Pressure Ammonia Gage
36"x7'0" Accumulator
Thermometer
8" Suction from Present freezing Tanks
Present freezing Tank No 3
5" Suction
7" Suction to 200 Ton D.L.V. Machine
Present freezing Tank No 4
14" Distributing Header
7" Suction to 220 Ton D.L.V. Machine
3½" Suction
½" Purge
Low Pressure Ammonia Gage
2" Pumpout Header
2" To Pumpout Machine
Present freezing Tank No 5
Thermometer
Present freezing Tank No 1
Thermometer
36"x7'0" Accumulator
8" Suction to 300 Ton D.L.V. Machine
6" Suction to York Machine
8" Suction to 300 Ton D.L.V. Machine

FIG. 7. SHOWING ISOMETRIC LAYOUT OF THE COMPLETE PIPING SYSTEM

The liquid-ammonia storage capacity was increased by the installing of three liquid-ammonia receivers, each 30 in. in diameter and 18 ft. long, all of the welded type, tested to 1000 lb. hydrostatic pressure. All connections into receivers are welded. Liquid inlet and outlet are all 4-in.; pump-out, drains, equalizers, etc., for all these receivers are connected together with welded headers. Each receiver is provided with a pop safety valve which discharges into a welded header and header piped to a large low-pressure suction pipe main (Figs. 6 and 11). Included with the suction gas-pipe system was the changing of the five ice-freezing tanks from horizontal coils to vertical coils and installing two vertical motor-driven agitators for each tank, which made a great improvement on brine circulation. All liquid and suction headers were welded and placed inside the brine tanks.

For cooling the water before entering the ice cans, there were installed two water coolers, direct-expansion type, having a capacity of 200 tons daily. Each tank contains 800 ft. of 2-in. extra-heavy pipe made up in hairpin-coil shape, having no joints—everything welded; these cooling tanks are provided with a separate 8-in. suction pipe direct to the high-pressure suction gas main into the large liquid traps. The water cooling is done at 30 lb. suction pressure; recording gages are provided for obtaining the temperature of the water in and out of the coolers, also temperature and pressure of ammonia gas leaving coolers.

The entire work, all pipes, headers, etc., every joint possible, was oxyacetylene welded throughout; flanges were used only where necessary, thus reducing the joints to a minimum, which of course keeps down the liability of trouble and leakage. See Fig. 7.

All pipe is of wrought iron, and valves, fittings, flanges, etc., are of cast steel or air-furnace iron; every piece in the whole system was tested to 500 lb. pressure under water and guaranteed for a safe working pressure of that amount.

The entire system is equipped with instruments of the recording type. Each header has a recording pressure gage, also a recording thermometer; all liquid lines in and out of the traps are equipped with indicating thermometers, also the gas mains in and out of the traps. So complete is the equipment of instruments that conditions in any part of the system are known at all times and not only indicated, but recorded, so daily logs can be kept. Provision was made at various points throughout the system for mercury-column connections, so all pressure gages could be checked and kept accurate, as this is considered important.

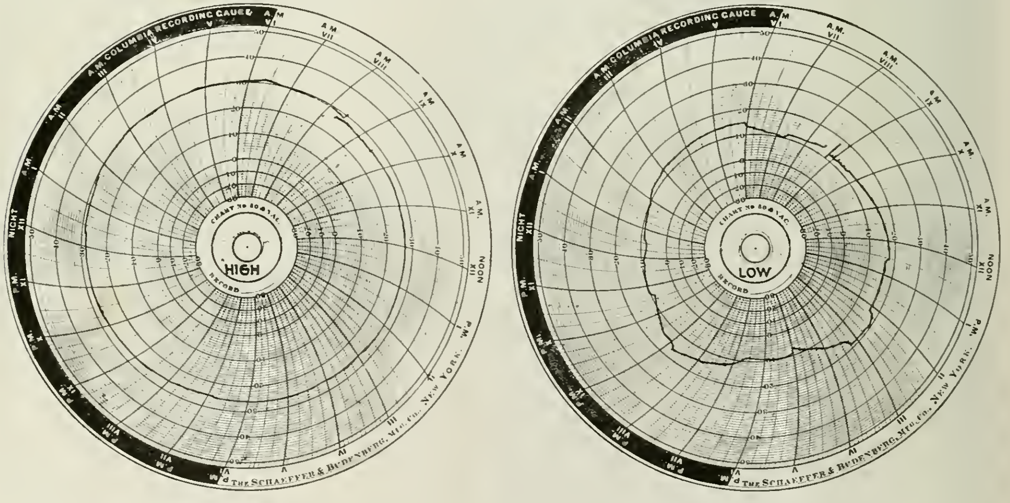


FIG. 9. CHARTS SHOWING THE PRESSURES OF THE HIGH- AND LOW-PRESSURE SUCTION GAS

The whole system is cork insulated, the various services having different thicknesses of insulation. All mains, pipe, fittings, valves, etc., have a 3-in. cork covering, while the liquid traps, accumulators, etc., are covered with 6-in. cork lagging. It might be well to call particular attention to the importance of insulating. In calculating the total surface of all mains, pipes, traps, water-storage tanks, liquid receivers, etc., and basing all calculations on an average outside temperature of 75 deg. F., the total B.t.u. loss per 24 hours of the uncovered surface amounts to 17,766,623 B.t.u. This same surface insulated shows a loss of only 1,510,052 B.t.u. and the saving effected is 16,256,571 B.t.u. per 24 hours, equal to

$$\frac{16,256,571}{287,000} = 56 \text{ tons refrigeration saved per 24 hours.}$$

The work was finished in June, 1917, and has been in

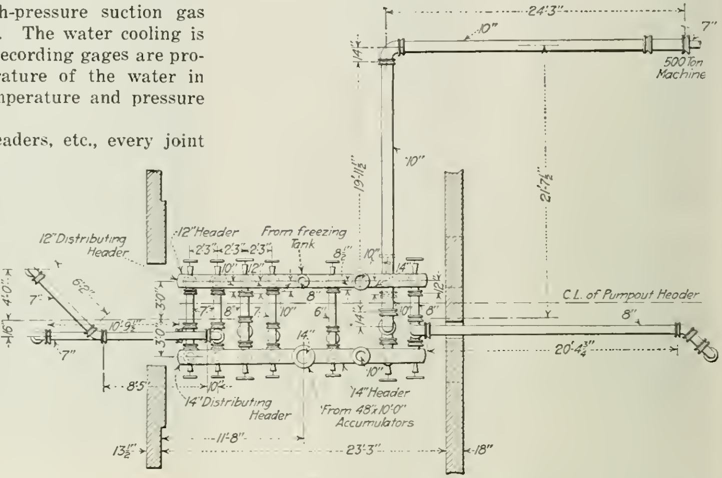


FIG. 8. PLAN VIEW OF 12-IN. AND 14-IN. DISTRIBUTING HEADERS

highly satisfactory operation since, accomplishing all that was hoped for. Charts from the recording gages, herewith shown, graphically illustrate the two ammonia suction pressures carried at this point. See Fig. 9.

Briefly, the economy gained in making the changes as outlined in this article were that the low-temperature and high-temperature suction gases were completely isolated from each other and the high-temperature work was done with high suction pressure and temperature, which was impossible in the old system of suction gas mains. The velocity of the gases in the mains was reduced to under 4000 ft. per min. as compared to 9000 and 12,000 ft., the velocity in the old mains.

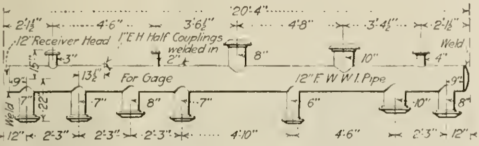


FIG. 10. THE 12-IN. MACHINE HEADER, GIVING DIMENSIONS

The size of the main from the stockhouses (14 in.) was decided on and based on the maximum load conditions of 1000 tons refrigeration daily, 28 lb. suction and 200 lb. condenser pressure, which gives a velocity of gas of 4000 ft. per min. Normally the operating load is approximately 800 tons daily, which reduces the velocity to 3200 ft. per min. Mercury-column readings taken at the most distant points on the line showed less than ½ lb. pressure drop; this, of course, brought very nearly the maximum evaporating-coil pressure directly to the compressor cylinders, instead of a drop from 5 to 8 lb. that existed in the old system of mains; the economy of this is self-evident.

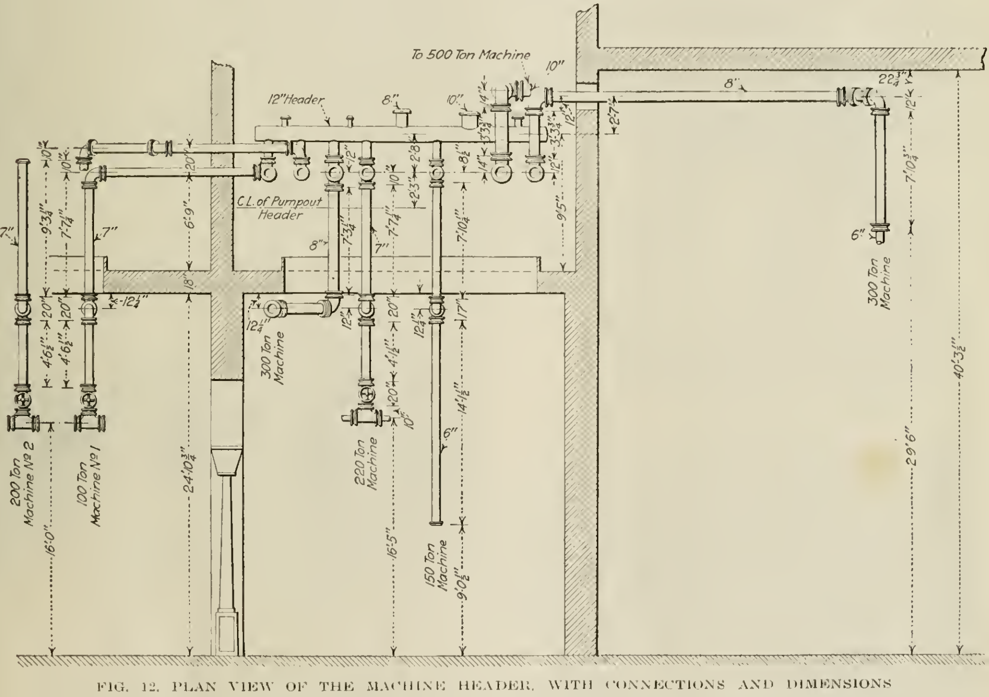


FIG. 12. PLAN VIEW OF THE MACHINE HEADER, WITH CONNECTIONS AND DIMENSIONS

It wholly corrected the former trouble of liquid entering the compressors; superheating is controlled and kept to within 5 to 10 deg. F. of the temperature corresponding to the suction pressure, and it is hardly ever necessary to use liquid injection in the liquid traps to keep it down, as we get just about enough entrained liquid with the return gases to obtain the desired results.

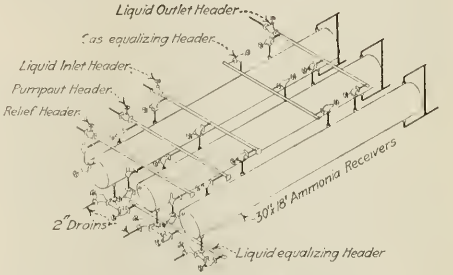


FIG. 11. CONNECTIONS OF THE AMMONIA RECEIVERS

Installing the large liquid traps, which also cooled the liquid ammonia from the condenser temperature to an average temperature of 36 deg. F., made a substantial saving, as follows:

If the liquid were not cooled and allowed to enter the evaporating coils at a temperature corresponding to the condenser pressure average, 150 lb. and 83.8 deg. F., the loss due to the liquid cooling itself to the temperature existing in the evaporating coils, before it could do any work, at 28 lb. and 15 deg. F., would amount to 13.5 per cent. The liquid-cooling traps cool the liquid to an average temperature of 36 deg. before entering the evaporating coils, therefore the liquid has only to cool itself from 36 deg. to 15 deg. in the evaporating coils, which causes a loss of but 4.18 per cent.

Looking at it another way, in the first case the compressor has to handle 3.6 cu.ft. of gas per ton per minute (assuming compressor efficiency 75 per cent) and in the second case only 3.26 cu.ft.; therefore $\frac{3.26}{3.6} \times 100$ equals 9 per cent., more work can be done by cooling the liquid from 83.8 deg. to 36 deg. before entering the evaporating coils, and for a plant doing 1000 tons of work this amounts to 90 tons per day.

The rearrangement of the ice-tank coils, together with the suction-gas mains resulted in increasing the ice-making capacity from 150 to 200 tons, or an increase of 50 tons of ice daily without adding any more evaporating coils or cans.

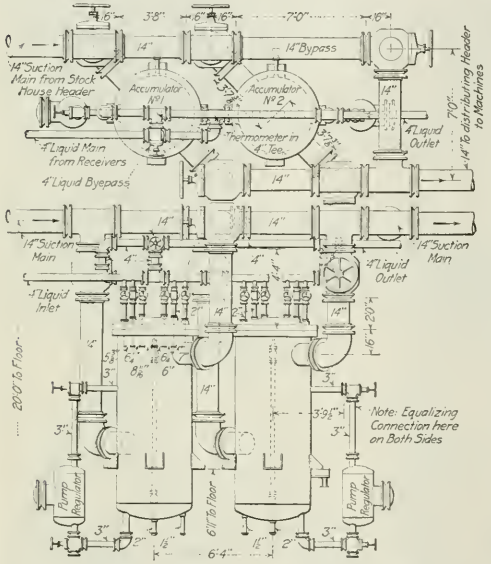


FIG. 13. THE LIQUID TRAPS, SHOWING ALL CONNECTIONS

Changing the operating conditions of the stockhouses' load from 15 lb. suction and 150 lb. condenser pressure (150 lb. being the average condenser pressure yearly), which required 1.61 engine horsepower, to 28 lb. suction and 150 lb. condenser, which requires only 1.17 engine horsepower, and figuring on an average load of 200,000 tons yearly of refrigerating work from the stockhouses, it means a saving of 2,112,000 hp.-hr., equivalent to 3168 tons of coal yearly.

It also resulted in taking care of an increased load, using two less compressors than formerly, besides greatly improving the economical operation of the compressors that now carry the load and doing away with some engine-room labor.

From a financial point of view the economical returns are such that the installation will easily pay for itself inside of three years.

Sullivan "Wafer" Air-Compressor Valves

Single-stage, belt-driven and steam-driven compressors of relatively small size are now being supplied with the new improved plate valves developed by the Sullivan Machinery Co.'s engineers at the Claremont, New Hampshire Works. This valve, known as the "Wafer," is shown in the accompanying illustrations. It seats in a cage arranged radially to the axis of the cylinder and close to the two ends of the cylinder; the inlet valve is situated at the bottom and the discharge valve at the top. These valves are held to their seats by flat annular steel springs. They open against guard plates designed to give a wide port opening with a minimum of clearance volume, without restricting the admission or discharge of the air to or from the cylinder. The valve, spring and guard are accessible by the removal of a screw plug. Owing to the simple and short construction of the springs, the valves can be located close to the bore of the cylinder to keep down clearance losses.

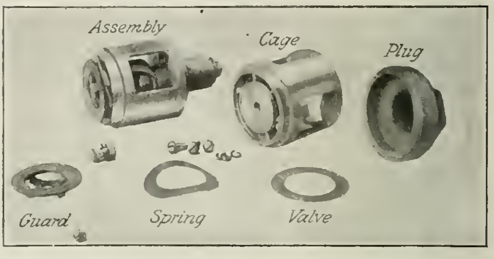


FIG. 1. "WAFER" INLET VALVE

Compressors equipped with these valves are unloaded in essentially the same manner as those equipped with automatic poppet valves. There is an air-pipe connection from the receiver, controlled by a pilot valve at the side of the air cylinder. When the receiver pressure rises to the unloading limit, the pilot valve admits air pressure through branch pipes to small plunger pistons in the valve plugs. The other end of the piston carries a three-pronged extension which raises the inlet valve from its seat until the receiver pressure falls the required amount, upon which the plunger piston falls, the valve seats and the compressor resumes its operation. While the valve is raised and the unloader is in action, no air is compressed, the piston of the compressor simply carrying the air at atmospheric pressure through the cylinder and open valves.

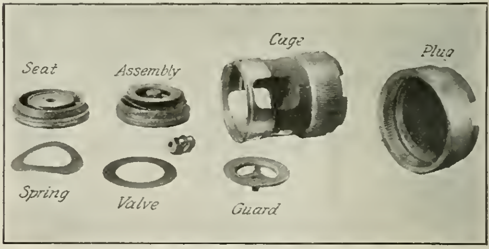
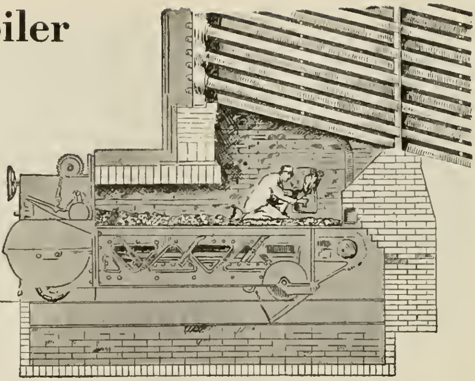


FIG. 2 VARIOUS PARTS OF "WAFER" DISCHARGE VALVE

Final Inspection of Boiler Plants

By D. G. WALLACE

This article presents a method of determining the presence of air leaks into a boiler furnace that differs from that generally employed. It is used in the final inspection of the boiler after repairs or other work has been completed and before the boiler furnace is fired up.



CONDITION of boilers and settings at the time they are put under load governs to a great extent their efficient operation. Inspection is often neglected, and boilers are assumed to be in good condition for a run when the cleaners have finished their work. This is poor operating because if a boiler is not in first-class condition when starting a run, it is next to impossible to get the best results later.

In one plant I have in mind the boilers get a general external inspection before being cut off the line for the purpose of cleaning and repairs and a further inspection when cool enough to enter, so that repairs can be made in an intelligent manner. When a boiler is thoroughly cleaned and repaired, the chief engineer makes the final inspection and fills out the report-sheet shown herewith. Under "Remarks," all extensive repairs or unusual conditions are noted, and this report is then placed on file for reference.

Before a boiler is fired, the following test is made for air leaks, the furnace being equipped with chain-grate stokers, although the plan would apply to other kinds. The height of the hopper gate is noted for a check on the final coal-bed thickness and coal is fed in until the grate is covered to the water-back. The coal thickness is then measured at a number of points over the grate to determine if the proper distribution has been made. The thickness of the fuel bed will be from one-half inch to one inch less than the gate opening. This is partly due to the friction of the gate and to the lack of sufficient pressure in the coal hopper. It is common practice to speak of the fire thickness as being the gate opening, which is an error. When the coal thickness has been properly checked the inspector goes inside the furnace with a torch, all furnace doors being closed, and the boiler damper is opened until the draft gage shows the regular running conditions. The inspector then tests for air leaks, which are indicated by a violent blowing of the flame of a torch. A person making this test for the first time will be surprised at the inrush of air to the furnace even in settings that are in good condition and considered tight. Of course most of the leaks are around the doors and other openings.

Air leaks that would be impossible to locate from outside the setting will be discovered in this manner. This test will also show whether the grate and wall baffles are tight and are or are not allowing an excess of air to pass into the furnace from the ashpit, between the waterback and the grate.

All other parts of the boiler are tested in a similar manner under a draft corresponding to operating conditions. With an air inspection and test of this kind a boiler should go into service in first-class condition and a high efficiency may be expected.

Boiler No.................................... Date..........

	Mechanical Condition	Safety	Notation
Boiler tubes			
Waterback			
Water trough			
Boiler shells			
Man heads			
Water-feed pipe			
Water column			
Column pipes			
Safety valves			
Blowoff valves			
Stop and check valves			
Stop valves			
Boiler and heater piping			
Steam gage			
Brick setting			
Baffles			
Damper and equipment			
Blowout doors			
Peep holes			
Chain grates			
Gate drive section			
Furnace gates tight			
Ashpit			
Ashpit doors			
Fine coal chutes			
Ash chutes			

Remarks..

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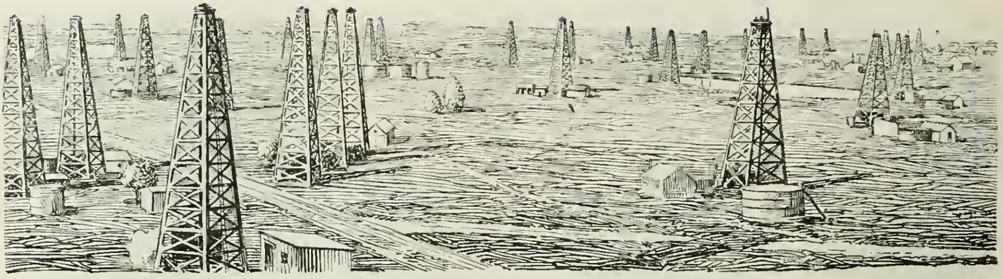
Chief Engineer.

The prospects of a good supply of oil fuel for Egypt are very promising. At the beginning of the war the Anglo-Egyptian Oilfields was the only one of the various companies formed to search for oil in Egypt that remained in operation, and down to 1914 the only finds of importance had been at Gemsah, where none of the gushers that had been struck had given anything like a permanent yield. But the new field discovered in 1914 at Hurgada has been proved to be of singularly regular formation, and its yield has steadily increased, until according to recent reports, it now stands at over 15,000 tons of crude oil a month. Meanwhile the Suez refinery has been enlarged, and there is every reason to hope that as much oil will shortly be available for internal consumption as can be dealt with by the company's existing facilities. It is stated that, in consequence, most of the public utility companies in Egypt have now converted their plants to burn petroleum residue.



Fuel Oil: What It Is and Where It Comes From

By RUFUS T. STROHM

SIXTY years ago this summer a man at Oil Creek in northwestern Pennsylvania started to drill a hole in the ground at a spot where he had observed oil oozing to the surface. At the end of three months of hard and discouraging work he struck oil, the flow of the well being over eight hundred gallons a day. That man was Col. E. L. Drake, and his achievement formed the beginning of a mighty industry that has encircled the globe, made the motor car and the airplane possible and ushered in what may be called the age of petroleum.

Nobody knows how petroleum was formed, but there are a number of theories to account for its origin. The one that is most generally upheld is the organic theory, which explains that the oil is derived from animal or vegetable material, or perhaps both, that was buried and acted upon by heat and pressure until oil was distilled from it. Crude oil, or petroleum, is simply a mixture of various hydrocarbons, or compounds of hydrogen and carbon, and the original hydrogen and carbon were contained in the animal and vegetable matter that was buried in the earth.

Of course such a process would be slow and would require ages of time. But a study of the layers or strata of rock and clay that form the crust of the earth shows that at one time land and sea plants grew in great profusion and that such animals as fish, mollusks and corals were very plentiful. The earth was subject to violent upheavals and sinkings in those early ages, and vast areas covered with plants were flooded by the sea. Similarly, bays and arms of the sea were closed into lakes by the rising of the ground.

Mud and silt, carried by streams, flowed into these lakes and into the sea and buried the plants and much of the animal life. Over the layers of mud and silt other layers of materials like rock, clay and sand were deposited as time went on. The pressure due to these thick layers of earth became enormous and produced heat, while the water that lay above the layers prevented the animals and plants from decaying, as they would do in the open air. The result of the heat and the great pressure on the buried vegetable and animal matter was to distill or drive off gases that later condensed into liquid form, and this liquid is what we call petroleum. Such is the organic theory of the origin of crude oil.

Now, petroleum does not occur in great underground lakes or pools. It is found in beds or layers of sand or porous rock, which it saturates in the same way as water saturates a sponge. Moreover, these oil-bearing sands are between layers of rock or clay through which the oil cannot flow, even under the great pressures that exist. The operation of obtaining the oil, therefore, is to drill a hole down through the overlying layers of earth and rock into the saturated oil sands. An opening is thus formed through which the oil can escape to the surface, aided by the pressure.

In proof of the statement that petroleum was formed from vegetable and animal substances it may be mentioned that the remains of such materials have been found in some of the oil-bearing regions. For example, oil wells in the Spindle Top District, in Texas, have been drilled through thick layers of vegetable matter containing tree trunks. In one of the oil fields of Russia the petroleum is found in strata in which the remains of fish are abundant. In most cases, however, the materials from which the oil is formed have been so completely decomposed and changed that no trace of them in their original state remains.

The common method of drilling is by means of a string of tools attached to a cable and given an up-and-down motion by a walking beam driven by a steam engine. The tool at the bottom of the string is the drilling bit, from 4½ to 6 ft. long, with a cutting edge that may have any one of a number of different forms. Above it and screwed into it is the auger stem, which is from 16 to 48 ft. long, and above that are the jars, which resemble two long chain links.

At the beginning the jars are not used, as the ground is fairly soft and the drill has no difficulty in penetrating. The weight of the string of tools is from 1½ to 2 tons, which is lifted by the walking beam and allowed to fall by gravity. The drill simply punches its way downward through the softer earth and pulverizes any rock that it strikes. After the hole has reached a depth of from 100 to 200 ft., the jars are screwed into the string. Their purpose is to jar the drill loose when drilling in rock in which the bit is liable to stick. The sudden blow delivered by pulling up the upper jar until it strikes the lower one will loosen the drill bit when a steady pull on the rope would fail to move it. The jars are not used to drive the drill deeper on the down stroke. If the rope is too long, the upper jar will strike the bottom of the slot in the lower one, but this is accidental and will eventually damage the jars.

The auger stem gives increased weight and force to the blow of the drill; also, on account of its length, it aids the drill in cutting a straight hole. Above the jars the sinker bar is attached. Its purpose, also, is to keep the hole straight, and when drilling a hole that is partly filled with water it helps to sink the cable more rapidly. It may be placed between the jars and the drill bit so that it may add force to the blows. To keep out water and to prevent the sides of the hole from caving in on the tools, a casing or lining of iron pipe is put down. It is made of threaded sections that are screwed together, new sections being added at the top at intervals, as the depth of the well increases. Above the well is erected the derrick, a tapering framework of wood or steel towering eighty feet or more in the air and enabling the tools or the casing to be withdrawn readily when necessary.

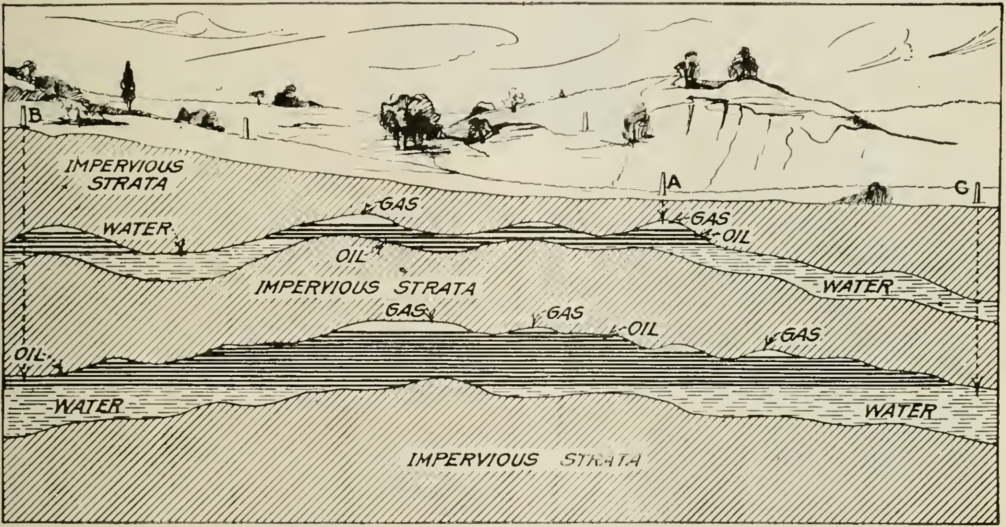


FIG. 1. VERTICAL SECTION OF CRUST OF EARTH IN TYPICAL OIL FIELD

If the well is put down in soft earth that tends to flow or cave badly, the rotary method of drilling is used. In this system the casing itself forms part of the drilling equipment. A steel cutting bit is screwed on the bottom end of the casing, which is given a rotary motion, with the result that it bores its way down through the ground. A mixture of water and clay is forced down inside the casing in a steady stream while drilling proceeds, and this mud flows out at the bottom and up to the surface around the casing, carrying with it the drill cuttings and at the same time tending to float the casing, thus making it easy to turn in the hole.

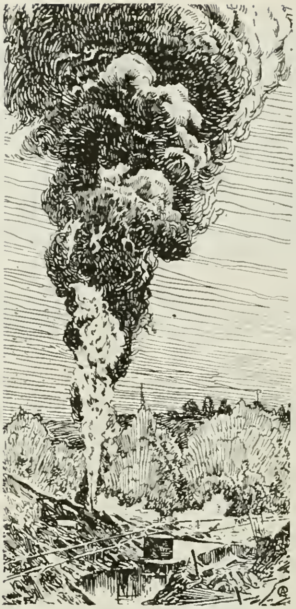
The depth of the well may be a few hundred feet or several thousand feet, depending on its location. This will be understood by reference to Fig. 1, which shows a vertical section through the crust of the earth in a typical oil field. The oil-bearing strata are not flat, but are tilted into folds or wrinkles and usually contain water in addition to oil. As the oil is lighter than the water, it floats on the top and so occupies the highest parts of the folds. If gas is present, it is found above the oil. Thus, if a well is drilled at *A*, it will strike gas and oil at a small depth; if it is drilled at *B*, it will have to go much deeper before oil is encountered; and if it is drilled at *C* it will strike no oil whatever. This will explain why some wells in a producing district fail to yield oil according to expectations.

When a well pierces the gas sand at the crest of a fold in the oil strata, there is likely to be a strong rush of gas at first, followed by the oil, which may spout to a height of a couple of hundred feet and may even carry away the derrick in the violence of its flow. A well that yields oil in this manner is called a gusher, and the quantity of oil discharged is sometimes enormous. For example, a well at Tuxpam, Mexico, several years ago flowed for some time at the rate of 160,000 bbl. a day.

Gushers are responsible for the loss of much oil. If the flow is greatly in excess of that expected and the available tanks for receiving it are inadequate, it is caught in hastily constructed earth dams. The result is loss through seepage of oil into the porous ground. An additional loss is involved by the evaporation of the lighter constituents of the oil and their escape into the atmosphere in the form of gases and vapors.

Accidental fires may cause great waste of oil. For example, a well being drilled in the region north of Tampico, on the Gulf of Mexico, struck oil on the Fourth of July, 1908. The drilling outfit was being operated by a steam engine, which was supplied from a nearby boiler.

The well gushed so rapidly that before the fire in the boiler could be put out, oil had reached it and had ignited. The result was that the spouting petroleum burned in a jet of flame a thousand feet high and sixty feet wide, making a glare that could be seen for a hundred miles. For two months the fire raged, consuming oil at the rate of 60,000 bbl. a day, and before it was put out it had caused a loss of more than $3,000,000.



Not all wells, however, flow in such a manner. Many of them contain so little gas that the oil must be raised by pumping. Even the gushers sooner or later decline in their production, and the accumulated experience of years makes it possible to predict with reasonable accuracy the output of the wells in a certain group. If the flow is sluggish at first, or if it has declined greatly, production may possibly be stimulated by shooting the well. This consists in exploding a charge of nitroglycerin at the bottom of the well.

A can containing several gallons of nitroglycerin and fitted with a detonating cap in its top is lowered to the bottom of the drill hole. Then a heavy piece of iron, known as a "go-devil," is dropped down upon it. The explosion that results shatters the strata at the bottom of the well and enlarges the opening around the foot of the well casing, thus enabling the oil to flow more readily.

The color of crude oil varies considerably according to the locality in which it is found as well as the manner in which light falls upon it. If viewed by transmitted light, as by looking through a sample of the oil, the color may be pale straw, yellow, red, brown, dark brown or black. In a few rare cases crude oils are colorless and are known as white oils.

When viewed by reflected light, crude oil shows a greenish florescence that is called "bloom." This can be removed by filtering the oil through fuller's earth. It is logically assumed, therefore, that the varieties of white oil found in scattered regions are simply darker oils that have filtered through the earth and have been deprived of their color in so doing.

TABLE OF BAUME READINGS AND EQUIVALENT SPECIFIC GRAVITIES

Baumé Reading	Specific Gravity	Baumé Reading	Specific Gravity	Baumé Reading	Specific Gravity
10	1 0000	27	0.8917	44	0 8046
11	0 9929	28	0 8861	45	0 8000
12	0 9859	29	0.8805	46	0 7955
13	0 9790	30	0 8750	47	0 7909
14	0 9722	31	0.8696	48	0 7865
15	0 9655	32	0.8642	49	0 7821
16	0 9589	33	0 8589	50	0 7777
17	0 9524	34	0.8537	51	0 7735
18	0 9459	35	0 8485	52	0 7692
19	0 9396	36	0.8433	53	0 7650
20	0 9333	37	0 8383	54	0 7609
21	0 9272	38	0.8333	55	0 7568
22	0 9211	39	0 8285	56	0 7527
23	0.9150	40	0 8235	57	0 7487
24	0 9091	41	0.8187	58	0 7447
25	0.9032	42	0 8 39	59	0 7407
26	0 8974	43	0 8092	60	0 7368

The specific gravity of petroleum varies from about 0.74 to 1.0, the lower value applying to certain of the white oils already mentioned. Ordinarily, however, the specific gravity is between 0.84 and 0.94. Some of the black oils of Wyoming have a specific gravity of 0.966. If the crude petroleum is exposed to the air for some time, its specific gravity will increase, owing to the evaporation of some of the lighter constituents.

The oils from different regions have characteristic odors, and these are so well recognized that the source of an oil may often be determined by the odor. Pennsylvania crudes, for example, are characterized by a gasoline smell. An aromatic odor similar to that of coal-tar oils clings to California oils. But if the oil contains sulphur, it will have a decidedly disagreeable odor, particularly if the sulphur is present as hydrogen sulphide.

To avoid the use of decimals in expressing specific gravity, the Baumé system is used in the oil trade. The Baumé scale is purely arbitrary, the point marked 10 corresponding to a specific gravity of 1.0 and the remainder of the scale being graduated in degrees up to 60. A scale having this range can be used for oils having specific gravities from 0.737 to 1.0, as indicated in the table. It should be noted that an increase in the Baumé reading corresponds to a decrease in the actual specific gravity of the oil; in other words, the heavier the oil the smaller is the reading on the Baumé scale. The values given in the table are correct for a temperature of 60 deg. F.

The oil that flows from the well or that is pumped from it is collected in stock tanks, where it is allowed to stand for a time in order that the sand and dirt may settle out of it, after which it is pumped through pipe lines to refineries or to places of distribution. At the refinery it is subjected to the distillation process, which consists in heating the oil in closed tanks so as to cause some of it to pass off as vapor, the vapor being afterward condensed to liquid form by cooling.

The heating is done progressively; that is, it is begun gently and gradually increased in intensity. The reason is because crude oil is a mixture of a large number of oils that boil at different temperatures. The details of the distillation process vary in different refineries according to the nature of the crude oil, but the subsequent outline will serve to indicate, in a general way, the method of procedure.

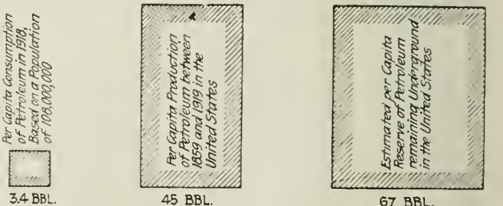
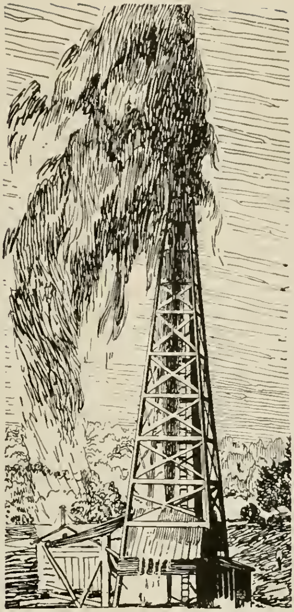


FIG. 2. DIAGRAM SHOWING OIL USED AND UNUSED IN UNITED STATES

The first vapors to be driven off under heating are those of the lightest and most easily vaporized constituents of the crude; namely, benzine, gasoline and naphtha. These have specific gravities higher tha about 52 deg. Baumé. Next the kerosene is distilled, this having a gravity of about 41 deg. Baumé. On further heating, solar oil or distillate oil is produced, which has a specific gravity of approximately 37 deg. Baumé and is used as fuel in oil engines. The next compound to be distilled is gas oil, which ranges from 24 to 26 deg. Baumé. The remainder of the oil in the still after the foregoing have been driven off is called residuum. It may be sold as fuel oil, for use in boiler furnaces or industrial heating, or it may be further distilled to produce lubricating oil, cylinder oil, paraffin and coke.

In a general way fuel may be defined as oil that is not marketable for some other special purpose at a price greater than that which the fuel oil will bring. Much of it is the residuum from the distillation process just described; but there is a considerable percentage composed of crude petroleum as it comes from the well, and still another large fraction is the residue from the skimming or topping process.



The topping process is simply a partial distillation of the crude oil, resulting in the recovery of gasoline and kerosene. The growing demand for these lighter oils in recent years makes their recovery not only profitable but imperative. The oil remaining after they have been driven off is very fluid. Most of the topping plants are west of the Mississippi, for the simple reason that the Eastern oils are too valuable to permit the loss of the lubricating oils and other products below the grade of residuum.

The extent to which fuel oil is used in the United States may be inferred from the fact that more than half of the total yearly consumption of petroleum is utilized as fuel for steam raising, this including not only the fuel oil produced by the refineries, but the oil used in its crude state as well. The whole southwestern part of the United States is dependent on oil fuel, because of the absence of near-by coal fields, and there has been a marked increase in the use of liquid fuel in the New England section because of industrial expansion brought about by war activities.

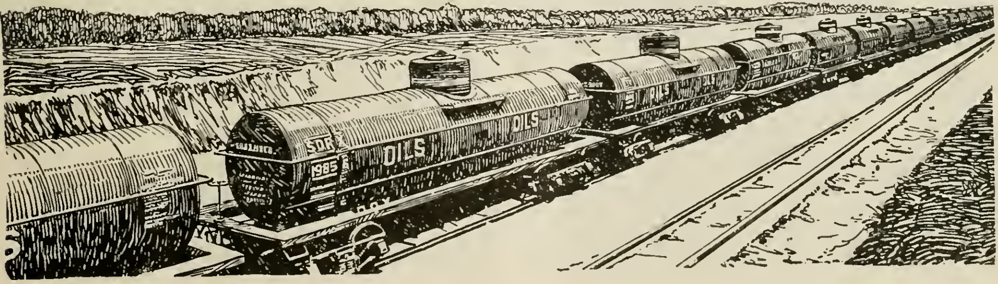
War demands placed an unprecedented burden on the oil industry, with the result that the rate of consumption greatly exceeded the rate of production, the difference being made up by importing oil and by drawing on the reserve stocks. During 1918, according to the statistics of the Geological Survey, the total marketed production of crude petroleum in the United States was 345,896,000 bbl. of 42 gal. each. In the same time the consumption amounted to 367,489,000 bbl., indicating that the domestic production fell behind the consumption by 21,593,000 barrels.

Because of the importance of fuel oil in the operation of steam boilers and the tendency toward its increased use in this respect, the matter of the available supply is of vital concern to the user. The Geological Survey has made estimates of the petroleum reserve in the United States as well as of the consumption since oil was discovered in 1859, and the figures are startling.

Assuming a population of 108,000,000, the consumption per person in the United States during 1918 was 3.4 bbl. The oil that has been produced since 1859 amounts to about 45 bbl. per person, and the oil yet underground, according to the most careful estimates, amounts to about 67 bbl. per person. These facts are shown graphically in Fig. 2. Now, if the population of the United States remained unchanged and the rate of consumption did not change, the oil available would last about 20 years. But the population is continually increasing and the demands for petroleum are multiplying, so that in less than 20 years the known domestic underground fields will be exhausted if the statistics are even approximately correct. Oil shales are not considered in this connection as a source of fuel oil.

This conclusion does not mean that fuel-oil users will be unable to obtain supplies, for the data apply only to the sources of petroleum within the United States. There are vast fields in Mexico and Russia, from which oil may be obtained, but of course at increased cost because of the transportation expense. Also, it is possible that additional oil deposits will be discovered as the older ones pass into decline.

Steam engineers in particular should be interested in the conservation of oil fuel, since they use more than half of the total production, indicating that approximately 200,000,000 bbl. of oil per year is utilized in steam generation. Taking into account the statement of the Bureau of Mines that 40,000,000 bbl. of fuel oil is wasted every year by inefficient and careless methods of firing, it may be seen that there is a wide field for the exercise of economy in the use of oil fuel.



Overload Protection for Electric Motors

BY O. C. CALLOW

Briefly discusses the different types of overload protection for motors, which are in common use, showing their respective disadvantages and shortcomings and suggesting other and better arrangements to suit various conditions.

ELECTRICIANS and operating engineers are familiar with the fact that the fuse was the first type of overload protection used for electric motors and circuits. The fuse as an overload protection will give good results when used with motors that run with a steady load and occasional light overloads and where the starting duty is normal. Owing to the fact that a fuse has a certain time lag equal to the time required for it to heat up and blow, it can be used on small overloads of short duration without shutting down the motor and still give good protection.

These points should be borne in mind when making an installation, and if the conditions of the load differ from those mentioned, then a better form of protection should be sought, as described later.

Being simple in construction, easy to understand and of low initial cost, fuses are not infrequently used where a little investigation will show that they do not give sufficient protection to the equipment against overloads. Take, for instance, the case of a drive which requires a large starting peak, such as a hoist, and which is controlled by means of a drum controller. The fuses have to be of such a capacity to withstand the high peaks that they are of little protection against a steady overload and will blow only in the case of a short-circuit. Serious damage can therefore be done to the motor under the conditions without blowing the fuses.

A point that cannot be too strongly emphasized is that whenever fuses are used they should be installed in a safety box provided with a lock and key and kept locked, also arranged so that the circuit must be open before anyone can attempt to draw the fuses. The writer has seen many accidents caused by means of open-type fuses. With the old type of wire or strip fuse there is always the danger of fire or of the molten metal flying into the operator's face. With the cartridge fuse this is avoided. Of course, there is the danger of someone removing a fuse while the load is on, in which case he will most likely only partly open the circuit, and thus start a heavy arc.

A further objection to an open-type fuse is the ease with which it can be shunted by means of a piece of heavy wire, thus defeating the very purpose it was installed for. In many cases when a fuse blows there is no spare at hand or no fuse wire, with the result that any conveniently handy piece of wire which is heavy enough not to blow again is inserted with little thought to the reason which first caused the fuse to blow.

These are conditions which actually exist in many plants and can easily be found upon careful inspection. The inclosed safety switch and fuse eliminates many of them, but much time is often lost in finding the operator who carries the key of the boxes and getting the necessary fuses of the correct size. One manufacturer of these switch boxes has been thoughtful enough to provide a spare fuse mounted inside the box, which often makes a great saving in time.

It is a surprising thing that in many plants that use both alternating-current and direct-current motors, the direct-current equipment is well protected and a large amount of money has been spent on magnetic control, making a first-class installation. The alternating-current motors, however, have to depend upon fuses for protection, and these are not always connected as they should be—arranged so that the starting current does not pass through them. This is a very important point when a compensator is used. The fuses should be arranged in the running side only, otherwise they will have to be heavy enough to carry the starting current, which is about three to four times normal when starting against full load with a squirrel-cage induction motor. It can readily be seen that the fuses would be worthless for overload protection in a case like this. The correct connection in this case would be as shown in Fig. 2. If the motors are small, below five horsepower, they can be started direct across the line, but a three-pole double-throw switch should be provided with the fuses connected in one side only, for the same reason as given (Fig. 1).

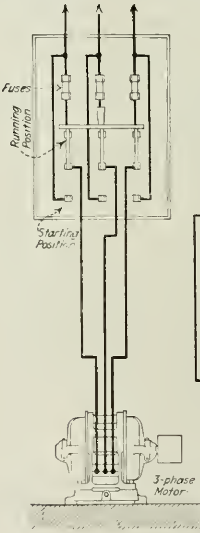


FIG. 1. MOTOR CONNECTED TO STARTING SWITCH

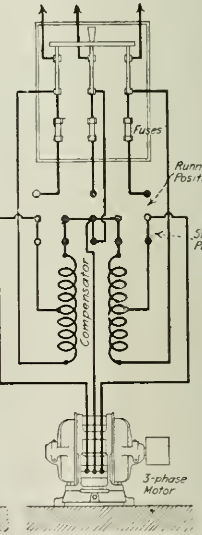


FIG. 2. MOTOR CONNECTED TO COMPENSATOR

A great improvement has been made in the overload protection of motors by the introduction and large use of magnetic control panels. With this class of apparatus it is usual to install two overload relays, one connected in series with each side of the line, and arranged to open-circuit the magnet coils of the line switches. These relays are calibrated for settings from 0.75 to 2.5 times full-load current and can be relied upon to open up the circuit when these values are reached. They are made either for hand or automatic resetting. With this arrangement the motor will be well protected and time saved in operation. Should a relay of this type open up the circuit in normal operation, with automatic resetting of the relay, the motor can again be tried without any loss of time and, if the overload was only momentary, will continue to run. If the overload continues, the relays will again trip, so that the motor cannot be started until the trouble is remedied. Furthermore, this type of protection does not lend itself to being tampered with to the same extent as fuses, and in the case of shutdown someone in authority is more likely to be notified.

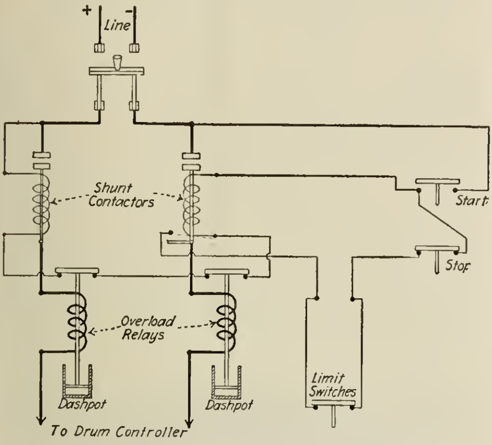


FIG. 3. CONNECTIONS FOR SHUNT CONTACTORS AND OVERLOAD RELAYS ON DRUM-TYPE CONTROLLER

Most of these types of relays are installed with an instantaneous trip, which is a great disadvantage when used on those drives where heavy peaks are encountered, as they have to be set at such a high rating that they lose much of their value as protection to the motors. This can be remedied to some extent by using inverse-time limits on the overload relays. These mostly take the form of an oil dashpot arranged to retard the action of the relay plunger and are provided with adjustments to suit different load conditions. With these attachments the relays will not trip on a sudden peak of short duration, which would be encountered in ordinary operation and which would not cause any trouble to the motors. They will, however, allow the relays to trip in the case of a continued overload and will give a fairly good protection to the motor.

One of the chief objections of the foregoing arrangement of relays is that they do not give much protection against a very heavy peak, owing to the fact that it is extremely difficult to design a dashpot that will both give the necessary retarding action and still open practically instantaneously on very severe conditions of heavy peaks. A good method of overcoming this trouble is to install two overload relays, one arranged with an instantaneous trip and the other with inverse-time limit. The latter type of relay should be set for ordinary operation, and protects the motor against steady overload and peaks up to a safe limit which would not harm the motor. The instantaneous-trip relay is then set to trip on any peak which it is decided is the limit that the motor would withstand with safety. As this is an instantaneous relay, it will open immediately the value is reached that it is set for, and shut down the motor. The addition of these relays can therefore be recommended for drives that handle heavy peaks and operate against large starting loads with quick reversals, such as steel-mill table drives and cranes.

The foregoing relays make a very good combination for use with drum controllers, particularly when made up into a panel with two magnetically operated shunt-line contactors. Complete protection is thus gained against overloads. A no-voltage relay can be connected, arranged so that the controller handle must be in the "off" position before the line switches can close, a very desirable arrangement in the case of failure of supply.

Limit switches can be connected in the control circuit to stop the motor at any given point, irrespective of the position of the controller; also, push-button stations can be provided to start or stop the machine from a distance in the case of trouble. A connection of this arrangement can be made as shown in Fig. 3. The addition of a good circuit-breaker is often warranted in connection with large motors to give complete protection. They should be built double-pole and should have overload and no-voltage trips and also time-limit device if the drive requires it. Circuit-breakers are now built that will stand a great deal of vibration without opening the circuit, and they can be used readily on cranes with good results. If a crane is equipped with drum controllers with fuses only for protection, circuit-breakers can be installed for each of the large motors. Full protection will thus be obtained and the life of the equipment very much lengthened. Time-limit devices should be arranged on the overload relays on the breakers and push-buttons can also be installed in connection with the no-voltage relay so that the breakers cannot be closed while men are working on the crane.

When a number of motors are located in one room, a very good arrangement can be made by installing a distribution switchboard containing a circuit-breaker for each motor, and thus no other protection is required. This can be carried out for either alternating or direct-current equipment. If the circuit is three-phase alternating-current, the breakers should be three-pole with two overload relays and time limits. For voltages higher than 440 alternating-current individual oil switches are to be recommended, equipped with the previously mentioned relays. Another good alternating-current installation can be made by placing a self-contained oil switch and compensator on each motor, or if the motors are of the slip-ring type, the control arrangement can be carried out with the rotor starters. The oil switches should have two overload and one no-voltage relays with time-limit attachments, so that they will not trip out during the starting period, which takes a large current during this time

The addition of an inexpensive ammeter mounted in view of the operator is often a great advantage with some drives and is a practice that might easily be followed to a much greater extent than is done at present. It enables the operator to know the load he is putting on the motor and teaches him to take a greater interest in the electrical end of the equipment. Again, on machines where a certain fixed production is required or where it is desired to obtain a uniform feed, this can often be gaged by an ammeter in the motor circuit better than any other method. Should trouble occur, either electrical or mechanical, the ammeter will show it at once and in many cases repairs can be made before anything serious happens. The foregoing will in most cases more than cover the cost of the ammeter.

In conclusion it may be said that a little thought and study of the conditions under which the equipment will operate when installed should be made, and the best type of overload protection should then be selected to meet these conditions.

"Lettgo" Mechanical Overload Release

When operating motor-driven machinery a circuit-breaker is usually depended upon to prevent overloading the motor. In other instances a shear pin is used to disconnect the driving power from the driven machinery when the load becomes excessive, but invariably a larger pin will soon be used, thus forming an element of danger to the machinery.

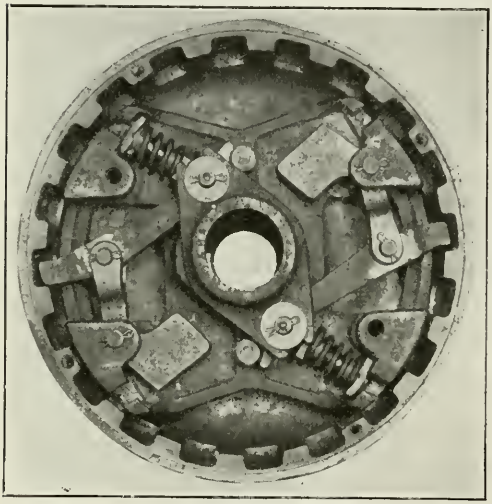


FIG. I. DEVICE IN DRIVING POSITION

In order to eliminate this danger the "Lettgo" overload release has been designed to automatically disengage the driving power from the driven machinery if the load exceeds a predetermined amount. The device will take care of an overhead gradually applied as well as an overload suddenly applied. It can be set so that it will not trip out from sudden jars or shocks such as are received in the case of a shearing machine. The springs are arranged to adjust the tension so that the release will operate at the proper load, and no matter how often it operates, the right factor of safety is maintained. The mechanism is inclosed and can be packed with grease to lubricate operating parts.

Fig. 1 shows the device in the driving position, except that the triggers are not against the shoulders at the periphery. Fig. 2 shows it in the release position, and Fig. 3 is a line drawing better showing the construction.

Referring to Fig. 2, the spider *A* keyed to the shaft *B* has triggers *C* pivotally mounted on the links *D*, with the ends engaging inside notches in the rim of the drum *F* and roller *K*. Springs *E*, regulated to any desired pressure by the adjusting nut *H*, hold the ends of the triggers on the rollers *K* under normal conditions, but when the drive is overstrained the compression of the springs will permit the ends of the trigger to drop into the position shown in Fig. 3, releasing the connection with the rim *F* and allowing the driven machine to stop.

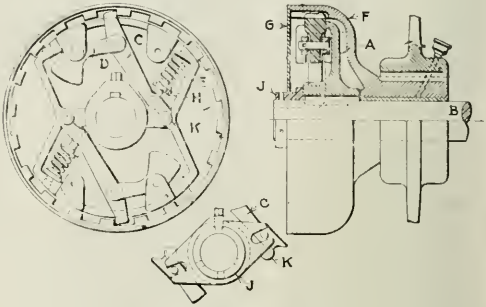


FIG. 2. SHOWING THE DETAILS OF CONSTRUCTION

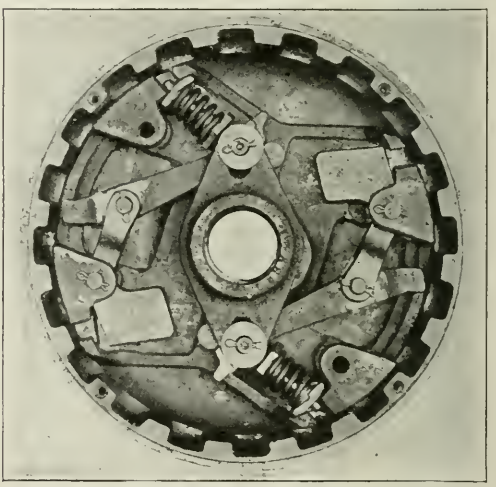


FIG. 3. DEVICE IN RELEASE POSITION

This device has been patented by Frank E. Aurand, 123 South Cuyler Ave., Oak Park, Ill.

A cement for leather belting may be made from equal parts of common glue and American isinglass. Place in a kettle and add sufficient water to cover, and soak for ten hours. Then bring the mixture to the boiling point and add pure tannin until the whole becomes ropey and appears like the white of an egg. Apply it warm. Buff the surface of the leather where it is to be cemented, apply the cement and rub the joint tightly together. Then let it dry for five or six hours.

The Electrical Study Course—Alternating Pressures and Voltages

Hydraulic analogies are given of alternating pressures, and then it is shown how, when a single conductor is revolved in a magnetic field, there is an alternating voltage generated in it.

CONTINUING the analogy of the preceding lesson, let us assume that we have a water cylinder with its two ends connected through a pipe, such as that illustrated in Fig. 1, and the whole system filled with water. Assume that a gradually increasing pressure is applied to the piston, to cause it to move to the right, so that this force will reach a maximum value when the piston has made one-half its travel. On the last half of the travel assume that the force on the piston gradually decreases, so that when the piston has completed its stroke the pressure has dropped to zero. This will cause the water to flow from *A* around to *B* through the pipe in the direction of the arrow *a*. After the piston has completed its stroke, assume that the force applied to it is reversed and gradually builds up so that it reaches a maximum value when the piston is at the midpoint on its return stroke, after which the pressure again gradually decreases and becomes zero when the piston has again reached the end of its stroke. This time it would cause the water to flow from *B* through the pipe into *A*, in the direction of the arrow *b*. The force applied to the piston in Fig. 1 may be represented by a curve to show the increase and decrease in pressure, in the following manner:

Draw a horizontal line such as xy in Fig. 2 and suppose that the distance ab upon it represents the length of the first half of the stroke of the piston to the right and bc the length of the second half of the stroke; likewise that cd represents the first half of the stroke to the left and de the second half of it. Furthermore, assume that the pressure on the piston is represented by vertical distances above and below the line xy, pressures to the right being represented by distances above the line and pressures to the left by distances below it. Let the maximum pressure be laid off equal to v and w respectively. At the beginning of the stroke to the right the pressure is zero. Since zero pressure is situated on the line xy, the first point a must be the first point of the curve, because it represents both the beginning of the stroke and zero pressure. When the piston has traveled the distance ab, the pressure has risen to a value v, and the second point on our curve will therefore be f. At c the pressure has again dropped to zero, so that c is the next point. From c to d the pressure is to the left, reaching its maximum at d, as indicated by g. Finally, at e the pressure is once more zero, giving the zero point at this location. If the pressure had varied uniformly, we could join the points with straight lines, as shown, but since that condition would hardly obtain, we might expect the pressure to increase and decrease perhaps after the fashion of some such curve as that drawn through a, f, c, g and e, in Fig. 3. It is evident that the shape of the curve may assume many different forms depending on the variation in pressure, but that there will always be a loop above the line xy and another one below it, for each complete cycle of the piston travel.

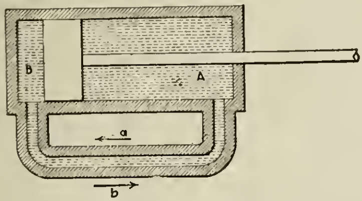


FIG. 1. CYLINDER WITH BOTH ENDS CONNECTED THROUGH A PIPE

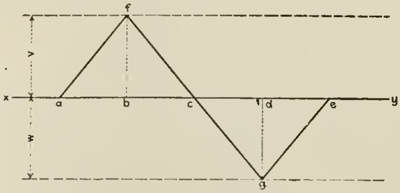


FIG. 2. DIAGRAM REPRESENTING A UNIFORMLY CHANGING PRESSURE

In the curves we have represented not only the pressure, but also the flow of water. The flow of water will vary in value and direction as the pressure applied to the piston. Then the curve above the line xy will also represent the flow of water in the direction of arrow a, and the curve below the line flow in the direction of b. The two curves represent what is called a cycle, that is, they represent the complete operation of the piston. The piston started from the left-hand end of the cylinder, moved down to the right-hand end and returned to the left-hand end, where it started from, making a complete operation, or cycle.

Let us now turn to a consideration of alternating electric pressures; that is, voltages. The simplest condition is that of a single conductor revolving around in the field of a two-pole magnet similar to that shown in Fig. 4. Assume that the magnetic field is uniformly distributed as indicated by the vertical dotted line between the pole-pieces and that the conductor revolves in a clockwise direction in the path marked by the dotted circle. According to the rule for the direction of a voltage generated in a conductor moving in a magnetic field, the conductor in the figure will have voltage generated in it away from the reader when under the N pole and up through the plane of the paper when under the S pole, as indicated by the cross and dot respectively on the end of the conductor.

When the conductor is in position a, Fig. 4, it will be moving vertically upward parallel with the lines of force and will not be cutting them, therefore no voltage will be generated in the conductor at this instant. The same is true of the conductor when it is in position g; at this instant it is moving vertically downward, consequently not cutting any lines of force. At b, c and d the conductor is cutting lines of force at different rates.

This is made apparent by considering the horizontal distance between a' and b', b' and c', c' and d', etc.

When the conductor moves from a to b, it has only cut the lines of force between a' and b', when it moves from b to c it cuts the flux between b' and c', and when moving from c *to* d it cuts the flux between c' and d'. The horizontal distance between b' and c' is greater than that from between a' and b', likewise that between c' and d' is greater than that from b' to c'. Consequently, if the conductor is moving at a uniform rate, the number of lines of force cut per unit of time are not equal, being zero at a where the conductor is moving parallel with the lines of force, and at a maximum at d where it is moving at right angles to the lines of force. Therefore, since the voltage generated in the conductor at any instant is directly proportional to the number of lines being cut per unit of time, the voltage in the conductors will be zero at a and maximum at d, decreasing to zero again at g, and then reverses and builds up in the opposite direction under the S pole, reaching a maximum value at j and decreasing to zero again at a.

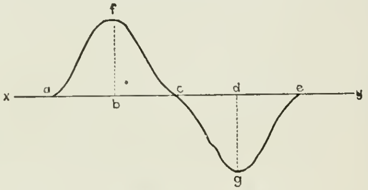


FIG. 3. CURVE REPRESENTING PRESSURE THAT DOES NOT VARY UNIFORMLY

The next question that arises is, What is the value of the voltage in the conductor at the different positions in the revolution? It can be shown, and will be taken up in a later lesson, that if the vertical distance between d and the line xy (that is, the radius of the circle the conductor is moving in) is let to represent the maximum value of electromotive force, the vertical distance between the conductor and the line xy at any other point will represent the voltage generated in the conductor at that instant. In other words, if the vertical distance between d and xy represents the maximum voltage, then the vertical distances between b and c and the line xy will represent the voltage generated in the conductor at these points respectively. Therefore to construct a voltage curve, all that is necessary is to lay off on a line xy, Fig. 5, distances ab, cd, etc., representing the different positions of the conductor in its revolution, and at each of these points on this line draw a vertical, as shown. Then take the vertical distance between the conductor and the diameter xy, Fig. 4, and transfer them to the verticals erected at the points b, c, d, etc., on the line xy, Fig. 5, and draw a curve through the point thus obtained, as shown.

One of the curves is called an alternation and represents, as has been shown, the value of the voltage generated in a conductor when passing under one polepiece. The two alternations generated by the conductor when passing under the N and S poles is called a cycle. That is, the voltage has completed a cycle by first increasing from zero to a maximum value and back to zero in one direction and then reversing and increasing from zero to a maximum and back to zero in the opposite direction, just as the pressure in the cylinder did in Fig. 1.

In the problem of the preceding lesson it was required to determine the shortest length of brake arm that it would be possible to use on a prony brake designed to test a 50-hp. motor up to 25 per cent. above normal load, if 1000 r.p.m. is its rated speed and if the largest platform scale available is one of 200 lb. capacity. Since the motor is rated at 50 hp., the load upon it at 25 per cent. overload would be $1.25 \times 50 = 62.5$ hp. We know that the power indicated by means of a brake test is expressed by the equation

$$P = \frac{2 \times \pi \times S \times F \times L}{33{,}000}$$

where P represents the power in horsepower, S the speed in r.p.m., F the force in pounds registered by the scale, and L the length of the brake arm in feet. The value of π is of course 3.142, and the factor 33,000 is used to give the answer in horsepower instead of foot-pounds per minute, as it would otherwise be. Substituting the known values in the foregoing expression, we have,

$$62.5 = \frac{2 \times 3.142 \times 1000 \times 200 \times L}{33{,}000}$$

in which F is taken as the maximum capacity of the scale; namely, 200 lb. From the foregoing we find that $62.5 = 38.08 \times L$, and consequently

$$L = \frac{62.5}{38.08} = 1.641 \text{ ft.}$$

which is equivalent to 1 ft., $7\frac{11}{16}$ in. If the capacity of the scale were greater, the arm could be made shorter; and vice versa, if the capacity were less, the arm would have to be made longer.

A 25-hp. motor runs 825 r.p.m. and is connected to its load through a $9\frac{1}{2}$-in. belt running on a pulley 10 in. in diameter. What is the pull in pounds on the belt when the motor is driving its full rated load? What is the speed of the belt in feet per minute? If the motor operates from a 230-volt circuit and requires 95 amperes at full load, what per cent. efficiency does it operate at?

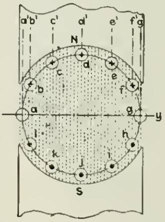


FIG. 4. CONDUCTOR IN MAGNETIC FIELD

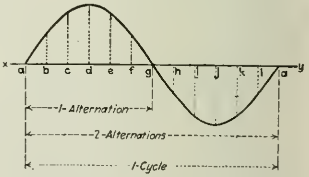


FIG. 5. CURVE REPRESENTING AN ALTERNATING VOLTAGE

Effect of Soot in Chimneys

By T. S. Clark

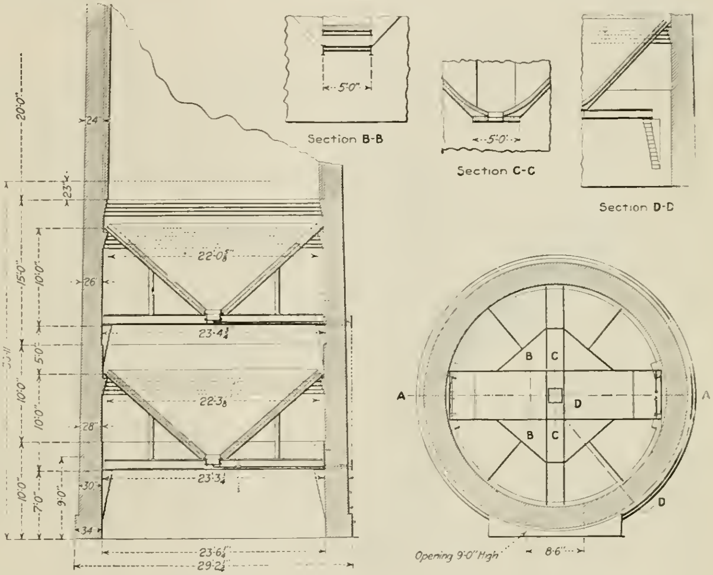
A mistake not rarely made in the maintenance of a power plant operating with a tall chimney is the neglect to keep the bottom of the chimney free of soot, cinders and other matter carried over from the boilers. This material collects at times in considerable quantities, particularly when the boilers are being forced to a heavy overload, and may accumulate to a depth of several feet.

During the recent war power plants all over the country were called upon to produce more steam and to produce it quickly. Boilers old and new were pushed to their maximum overload by any means at hand, irrespective of coal economy or any other economy. It was a question of more steam and more power at any cost. Under these conditions it was not unusual to overload the chimney by forcing the gases to its foot with the use of fans. From there a retardation of velocity took place and the matter carried in suspension was deposited in the foot of the chimney.

It is a fact that this material, though difficult to burn in the open air, will burn and glow under certain conditions when confined in the foot of the stack subjected to the chimney draft. High stack temperatures are produced. Explosions due to certain gaseous conditions are not unknown—a state of affairs that is liable to work to the detriment of a valuable and expensive structure and that is due wholly to neglect.

In a number of cases the writer has been called upon to examine the insides of chimneys where this condition of affairs has existed. Brick and steel adjacent to the accumulation in the foot of the chimney were found actually fused, indicating temperatures far over 1800 deg. F. Where the fusing of the steel took place, temperatures over 2200 deg. F. must have existed. Now, in these cases the chimneys were operated on boilers in boiler plants. Does the plant engineer want any stronger evidence of the importance of being watchful of the chimney and keeping it cleaned out?

In chimneys of not unusual size a clean-out door is built in the wall at the foot, not as an ornament or as a place to advertise the builder's name, but for the specific purpose of cleaning. In the case of chimneys ranging from 250 to 500 ft. in height, and of unusually large diameter, where it is difficult to reach all the area at the bottom with a long-handled shovel or a long hoe, special means are provided for cleaning. A slanting floor is sometimes built on the interior, just below the flue opening, leading to a chute or thimble built into the walls of the structure, through which, with the help of an iron bar on a rake, the débris may be removed.



SECTION OF CHIMNEY SHOWING SOOT HOPPERS

The large radial brick chimney 300 ft. high and 19 ft. in diameter inside at its top, built in 1917 for the Arlington Mills, Lawrence Mass., by the Alphons Custodis Chimney Construction Co., presents a novel and efficient method for the removal of soot and cinders from a chimney of great interior area. Below the flue opening in the interior of the stack two superimposed hoppers were installed, as shown in the vertical section. The frame was built of structural steel and the floor of reinforced cinder concrete, lined with brick. Two hoppers were used in order that the door in the lower one might be closed while that in the upper one was open. This prevented any chance of an open draft up the chimney through both hoppers.

While the lower hopper is receiving its charge of soot from above, the door in this hopper is closed. Doors were provided in the chimney at grade, large enough to allow a cart and team to back in under the lower hopper. The material is dumped into the cart by opening the door in the lower hopper, the door in the upper hopper being previously shut. Means of access to each hopper were provided through a manhole near the top. These openings were reached by an outside ladder built into the walls of the chimney. Around the upper rim of each hopper is a gallery from which a man, if necessary, can assist in a thorough cleaning of either hopper.

Two explosion areas were provided in the floor of the upper hopper. This was accomplished by building into the floor iron-plate doors hinged to open upward. This precaution was taken to relieve any pressure that might occur in the closed area between the hoppers.

Of necessity the chimney of a power plant has to keep pace with the development of the engine, turbine and boiler, in size and capacity. It has taken its place as one of the most important adjuncts. It represents in many cases investments ranging from ten thousand to over a hundred thousand dollars. Too many cases have occurred where the chimney has not been given the small and necessary attention of an inspection or a cleaning out of the bottom that the investment in the structure warrants.

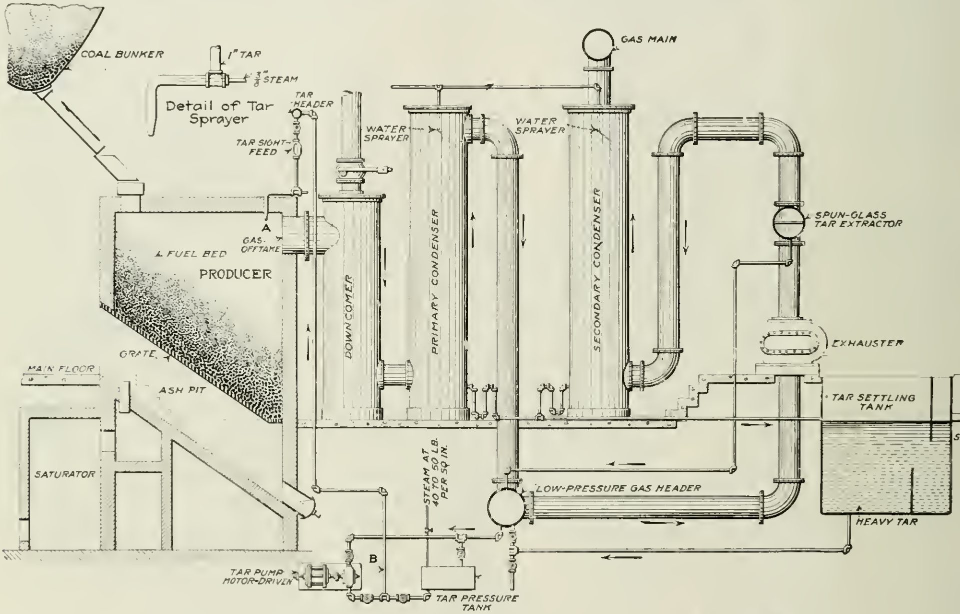
The occupational classification of people employed in the United States is as follows:

		Per Cent.
Agriculture, forestry and animal industry	12,666,000	33.2
Manufacturing and mechanical industries	10,855,000	28.4
Trade, retail, wholesale and miscellaneous	4,347,000	11.4
Domestic and personal service	3,795,000	9.9
Transportation	3,199,000	8.4
Professional service	1,713,000	4.5
Extraction of minerals	1,060,000	2.8
Public service	533,000	1.4
Total	38,168,000	100.0

Tar Disposal in Ford Producer-Gas Plants

Disposal of producer-gas tar by burning it under boilers offered so many objections that a method of returning the tar to, and vaporizing it in, the producer was developed. So far as known it is the first time that this method has proved a success in practice.

IN THE manufacture of producer gas there is formed a large amount of coal tar, which passes over with the hot gas in the form of a vapor and, when cooled, condenses into a tar fog consisting of finely divided particles that remain in suspension. This tar must be removed from the gas to avoid clogging of gas burners, sticking of engine valves and obstructing of gas-pipe lines. Along this line the Ford Motor Co. is doing the unusual in that the tar is returned to the producer, discharged over the fire and successfully vaporized. The accompanying diagram of piping and much of the descriptive matter of this article apply particularly to the gas-producer installation of the plant at Ford City, Ontario, but are also more or less typical of the Highland Park and Dearborn plants. For a general description of the Ford City plant reference may be made to *Power* of Aug. 6, 1918.



DIAGRAMMATIC VIEW OF ARRANGEMENT OF TAR-PIPING SYSTEM

Referring to the diagram, the path of the gas is from the producer through the downcomer and primary condenser to the low-pressure gas header. The gas from the several producers comes together at this point. The several gas exhausters receive their supply from this header and discharge through spun-glass tar extractors in parallel, thence through secondary or cooling condensers to the gas-distribution main or header. Considerable tar is removed from the gas by water sprays in the primary condensers and practically all the remaining tar is removed by the spun-glass tar extractors. A trace is removed by aftercooling water sprays in the secondary condensers.

At present the cooling water from the primary and secondary condensers is mixed and sent to the tar-settling tank where most of the tar settles to the bottom. The water from the secondary condensers in a short time will be diverted directly to the sewer, thereby increasing the efficiency of tar separation from the primary water. The low-pressure gas header acts as a tar receiver. The tar flows by gravity, assisted by the head of water in the settling tank and the gas-exhauster suction, from the tar-settling tank to the low-pressure gas header. The tar from the spun-glass extractors likewise flows back by gravity to this same gas header, assisted by the difference in gas pressure on the two sides of the exhausters.

Previous to 1916 the tar was a waste product of the gas-producer plant and was hard to dispose of on account of its pitchy nature and the impurities it contained. It was got rid of by being sprayed into the boiler furnace. The small saving in fuel in no way repaid for the nuisance of the frequent plugging up of the tar lines, clouds of black smoke from the stacks and the mess in the plant.

It seemed desirable to dispose of this tar by gasifying it in the producer. All efforts along this line previous to August, 1916, had been so uniformly unsuccessful that it was generally admitted at that time that the idea was not practicable. However, on the suggestion of H. F. Smith, of the Smith Gas Engineering Co., who had previously done considerable work on the problem, another attempt was made at the Highland Park plant, which established the fact that the tar could be gasified and would increase the heat value of the gas. Profiting by this experimental work, when the Ford City plant was put into operation the producers were piped up to dispose of all tar. The development of details has been rapid. The several plants differ materially in respect to details of construction and operation, yet the essential features are the same and each accomplishes the same general results.

Temperatures are the most important factors in the handling of the tar. Good practice requires that the gas leave the producer at a temperature of approximately 1000 deg. F. In the primary condenser the gas should be cooled down to about 125 deg., this being about the lowest temperature at which the tar remains liquid. If cooled too much, the tar particles will stick and build up on the spun-glass extractors. The temperature of the gas leaving the secondary condenser should be as low as the water supply available will permit in order to eliminate the last trace of tar and moisture.

METHODS OF FORCING THE TAR TO THE SPRAYERS

The tar that is collected in the low-pressure gas header in the basement may be pumped to the tar sprays in each section of the producer by a small rotary pump. The speed is regulated so as to return the tar at a slightly higher rate than it is received from the tar extractors and tar-settling tank. The pump may then be shut down, if desired, at times of light load.

As an auxiliary to the pump a small pressure tank is installed below the low-pressure gas header. The tar flows by gravity into this tank, which has an overflow so that the small amount of water that may accumulate can be drawn off. When the tank is full of tar, the connections are closed off and steam is admitted at a pressure of from 40 to 50 lb. per sq.in. The tar is discharged through a pipe from the bottom of the pressure tank and delivered to the producer sprayer *A* through the same pipe line *B* into which the tar pump discharges.

The advantage of the pressure-tank method of handling tar is that it has no moving parts and the pipe line and all connections are blown clean of the tar by the steam after the tank has been emptied. On the other hand, the tar pump has the advantage of giving a more constant feed of tar to the sprays.

In the Ford City plant a 96-gal. pressure tank is used in preference to the tar pump. The objection to an intermittent supply of tar to the fire has recently been overcome by first delivering the tar to an overhead storage header running the full length of the battery of producers. The tar sprays are supplied continuously from this header. With continuous operation and constant maintenance of temperature throughout, it has been found possible to keep the tar so fluid that it is being fed like oil through sight feeds to each section of each producer.

The sprayer by means of which the tar is atomized and distributed over the fuel bed is made by placing a ⅜-in. steam pipe inside a 1-in. tar pipe. The ends of the steam pipe and tar pipe are reduced in area so as to increase the velocities of the steam and tar to aid in the atomizing. The ends of the sprayer are approximately flush with the bottom face of the top lining of the producer.

Vaporizing the tar increases the heat value of the gas about 10 to 15 B.t.u. per cubic foot. The difference shows up in the analysis of the gas in an increase of from 1 to 2 per cent. of methane, accompanied by a slight reduction in the percentage of hydrogen.

The chief trouble encountered when first returning the tar to the producer fire was the formation of soot when the tar was sprayed onto a fire that had holes in it. This soot, if allowed to accumulate, would plug up the spun-glass screens in the tar extractors in a very few minutes. It is necessary to keep the fuel bed in good shape and free from holes when spraying tar. The tar should be evaporated over the full area of the fuel bed and not burned as would be the case were there a hole in the fire. Five sprays are employed to insure even distribution over the fire. With a smaller number the fuel bed under each spray became saturated with tar.

In the past considerable trouble has been experienced from solidifying of the tar in the pipes when the pump was shut down. This may come about due to cooling or to "baking." If the tar is allowed to cool in a pipe line, it is difficult to get it moving again. Provision is therefore made in every case for blowing tar from the pipe lines by the use of a ¼- or ⅜-in. low-pressure steam line run either inside the tar pipe or, preferably, on the outside and inclosed in the same pipe covering. The pressure on these steam lines should be five pounds or less. Tar should not be allowed to remain quiescent for any considerable length of time in a pipe even though heated, since the lighter oils will distill off and the residue harden or bake in the pipe, making a condition as bad as or worse than when it solidifies owing to cooling. The new sight-feed tar system requires that the temperature of the tar be maintained at about 160 deg. F., and for this purpose a low-pressure steam pipe is run inside the tar header over the producers.

Efficient Use of Water Power

BY W. F. UHL

Perhaps the subject of this article is not so important as the efficient use of fuel, as there is not nearly so much water power in existence as fuel-produced power; but anything that can be done to reduce the demand for fuel and at the same time increase the amount of available power is of great importance at this time. The water powers were at least partly responsible for the early lead that New England took industrially. Yet the growth of industry was so rapid that these powers soon proved inadequate, and where in the beginning most water powers were supplemented by some steam power, at the present time, with a very few exceptions, most New England water powers are mere adjuncts to steam power plants.

Redevelopments that have been made have been mostly of a partial nature, such as the replacement of turbines, often of doubtful advantage as to efficiency, but sometimes producing increased power when plenty of water is available. Generation of electric power has brought about some changes in these conditions, and a few of the more favorably situated water powers have been redeveloped along fairly modern lines. Heretofore the redevelopment of many of the existing water powers was of doubtful advantage considered purely from an investment basis, and under past conditions there was, with a few exceptions, no other proper measure of judgment available.

The question generally resolved itself into one of a saving in the coal pile. If additional money spent on the water power showed a saving in the yearly coal bill, it was justified; if not, the old plant could be operated until repairs became excessive and then it must be abandoned. There were a few exceptions to this rule in the case of those plants where the dam and sometimes other parts of the hydraulic development had become adjuncts to the more important steam plant for condensing purposes or for the use of water for manufacturing purposes, in which case such part of the water-power development could be partly or wholly charged to the steam plant or to manufacturing, or both. Again, in some plants a part of the machinery is often run overtime or at night, and it might prove fairly uneconomical to run the steam plant for such a small load, whereas the smaller water power might be used at small cost.

A Decided Change in Conditions

There are other such special cases which in the past have justified the redevelopment of some water powers that might not otherwise have proved desirable. But all these measures have now changed. It is no longer a question of a proper investment where power is concerned, but a question of getting reliable power at any cost. Nor are conditions ever likely to return to those of a few years ago. Even if fuel can again be obtained in any quantity desired, who doubts that its cost will be much greater than it has been in the past? Furthermore, there is always the danger of another crisis and a small amount of water power will be better than no power at all.

Assuming that no further argument is necessary to establish the fact that the water powers of the country, wherever there is a use for power, can generally be developed or redeveloped to economic advantage, it is of the greatest importance that they be so developed that the most power possible can be obtained from them. This does not mean that equipment of great capacity should be installed, but that such equipment as is installed shall be highly efficient in the use of the available water, always remembering that the fatal weakness of water power is its variableness.

The size of a manufacturing plant that a water power can continuously operate, or the size of a fuel-burning plant necessary to supplement a water-power plant, is dependent upon the minimum power that can be obtained at any one time from the power. It is therefore important not alone from the standpoint of saving in fuel that the water power be efficient, but also from the standpoint of dependence that can be placed on it.

Advance in the Art of Hydraulic-Turbine Design

The advance in the art of hydraulic-turbine design and installation in the last ten years has been marked, and modern installations properly made average about 85 per cent. efficiency, with a maximum of 90 per cent. This represents an increase of 20 per cent. in power and can be obtained with no more water but simply through more efficient use of head and water formerly used.

One of the rivers in Massachusetts, the total drainage area of which is about 400 square miles, has over twenty small power developments with heads varying from 8 ft. to 23 ft., a total development head of about 320 ft. and a rated turbine installation of about 7500 hp. Of this, 4500 hp. is used for 24-hour power and 3000 hp. for 10-hour power. Most of the turbines were installed some time ago, and their average efficiency is probably about 65 per cent., with a maximum of 75 per cent., while the actual maximum output is probably not over 6500 hp.

Some of the present developments would justify larger installations. Through a proper redevelopment of the present powers on this river, it is estimated that 21,500,000 kw.-hr. more could be obtained in the average year, at a cost that would be within commercial limits on a fuel-saving basis.

Cost of Storage Reservoirs

Storage reservoirs, although highly desirable wherever they can be commercially developed, would not show commensurate results on this river. The first cost would be very high principally on account of their number and small capacity and on account of the diversity of interests of the users. On rivers where there is a diversity of interests some plants running 24 hours daily and others for shorter periods, or where the heads are low and the ponds small, or any combination of these circumstances exists, it is always impossible to make full use of the stored water. One of the chief difficulties would be to let water out of the reservoirs in such a way that it would arrive at each plant at a time when it could be used. Under most cases of this kind probably not more than 50 per cent. use of storage would be made.

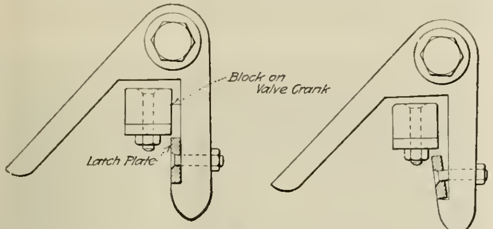
The investment warranted for storage in such a case would then not be over about $0.60 per million cubic feet per foot of head. One million cubic feet of stored water under one-foot head is equivalent to about 18 kw.-hr. on the power-plant switchboard, assuming 100 per cent. use of stored water. Probably $0.0075 per kw.-hr. is a fair average for the value of coal saved by stored water. This would be the case on the basis of 2.5 lb. of coal burned per kilowatt-hour in a steam plant with coal at $6 per short ton. The saving on account of fuel due to 18 kw.-hr., or one million cubic feet of storage water per foot of head, is then about $0.75 \times 18 = 13.5$c. Control and maintenance of reservoirs would probably average 1.5c. per million cubic feet per foot of head, which would leave a net saving of about 12c. per million cubic feet per foot of head. Capitalized at 10 per cent., this would warrant an expenditure of about $1.20 per million cubic feet of stored water per foot of head, assuming that it is used completely for every foot of head.

On a river where there are a number of powers, each with a considerable head and a pond of considerable capacity, all owned by the same interests, it is possible to use stored water almost completely in some years. In other years it may be difficult to make use of much storage, either because it is an exceptionally wet year or because the reservoirs did not fill in the spring. It is exceptional to find 75 per cent. use of stored water where there is a diversity of interest, and in most cases 50 per cent. is probably nearer the actual figure.

Sometimes the pistons of duplex pumps do not make full stroke in starting. This is usually caused by too tight packing of the stuffing-boxes. To prevent leakage where the boxes are properly packed it is only necessary to draw lightly on the glands, thereby saving friction. Steam valves are given the proper position by the manufacturer before shipment. When difficulties ensue in the operation of the pump, investigate the water end first before disturbing the adjustment of these valves.

Flywheel Accident at Corinth, N. Y.

On Mar. 9 a flywheel exploded in one of the paper mills of the International Paper Co., at Corinth, N. Y. The wheel was mounted on the shaft of a Corliss engine. It was 15 ft. in diameter, had a 50-in. face, and contained two double sets of arms, there being altogether twelve spokes in the wheel. It carried a double leather belt 48 in. wide.



HOW LATCH BLOCK CAME LOOSE AND LOCKED TO VALVE CRANK

In this accident the flywheel not only was completely demolished, but there also was demolished a receiving pulley 70 in. in diameter and 50-in. face, containing twelve arms. The engine was damaged very little, but some of the pieces of the flywheel were hurled through the floor and others through the ceiling into a paper machine, which was more or less damaged.

The cause of the accident was centrifugal force due to the racing of the engine. The racing was caused by the loosening of the latch plate on the hook of the valve mechanism. This loosening of the latch plate prevented the knockoff mechanism from disconnecting the hook from the valve crank, as a result of which the engine took steam full-stroke on that end. The load being light at the time, the speed increased until the main driving belt broke. Then the engine, free of all resistance due to its load, raced and burst the wheel by excessive centrifugal force.

There is a very good lesson in this accident—one that most operating engineers will thoroughly appreciate. It appears that the latch plates on the hooks of this engine became loose or were broken off so frequently that a stock of these plates, together with their attachment bolts, was kept on hand. When a broken bolt was replaced, no one seemed to have tried to increase the strength of the bolt so that a recurrence of the accident would be unlikely to happen. But when this serious accident followed—namely, the explosion of the flywheel—then a suggestion was offered for the strengthening of the bolt. This suggestion consisted of a recommendation that the new bolt be an ordinary standard S. A. E. bolt with castellated nut, cotter-pinned in place. This bolt not only is made of a better grade of material, but the threads, being finer, will give a greater area to resist fracture than the other type. Then, too, the castellated nut, cotter-pinned on, will prevent the loosening and the consequent hammer blow shock tending to further damage or breakage.

Chart for Finding Coal Loss in Percentage of Coal Fired

By D. G. Beaman

The easily read chart shown herewith should be useful to power-plant engineers, enabling them to readily find the coal loss during combustion, expressed in percentage of the coal fired.

To read the chart, assuming the figures given below: From a point indicating 6 per cent. CO_2 on the scale at the bottom of the chart (as indicated by the dotted line), proceed vertically to the curve marked 700 deg. F., the flue-gas temperature. The proportion of the heat in the coal fired which is going out with the flue gases is given by the scale at the left as 56 per cent.

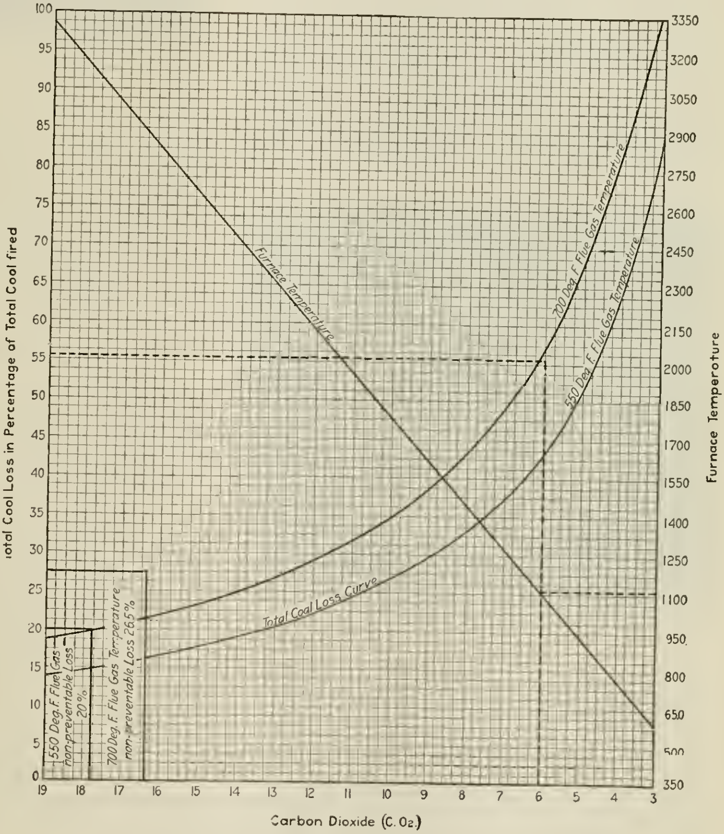


CHART TELLS PERCENTAGE OF COAL LOST DURING COMBUSTION

Rear Head of Steam Drum Fails

An explosion due to the failure of the rear head of a steam drum on a B. & W. (English built) boiler, occurred on the morning of June 12 at the works of Wm. Crane & Sons, Newmarket, Ont., Canada. The failure occurred at the flange where the head was riveted to the drum. The building in the immediate vicinity of the boiler room was wrecked, the escaping steam and falling débris causing the death of five persons and severe injuries to several others.

The boiler was nine tubes high by fourteen tubes wide and was of the ordinary double-drum type. Fig. 1, a view of the steam drum, shows that the drum head was defective for about three-quarters of its circumference, in the part below the water level. It is evident from the illustration that the fracture occurred at the bottom of the head, for the protruding piece of the head at the top is turned upward, after which the head sheared from this upper portion and was blown through the roof.

Fig. 2 shows the head from the inside, also the manhole plate in place. A 6-in. stop valve was connected to the back end of an equalizing connection, and an auxiliary line supplied steam to dry kilns, etc., Each drum had a 4-in. safety valve.

An examination of the boiler disclosed three primary conditions. First, the fractured head showed an area of defective metal that extended around the circumference from about 45 deg. above the center line on each side, as shown in Fig. 1; second, the rest of the metal seemed to possess its original qualities, as indicated by the elongation of the metal before it was finally torn from the major part of the head; third, the 6-in. steam pipe had parted from the elbow, the threads of which were found stripped for about five threads back. The equalizing header, on which the 6-in. connection was mounted, was found bent back about 20 deg. from the normal position. This, it was argued by the editor of *Power House*, from which our illustrations are taken, was probably the initial cause of the explosion, the sudden escape of steam and the accompanying water-hammer effect blowing out the already weakened head.

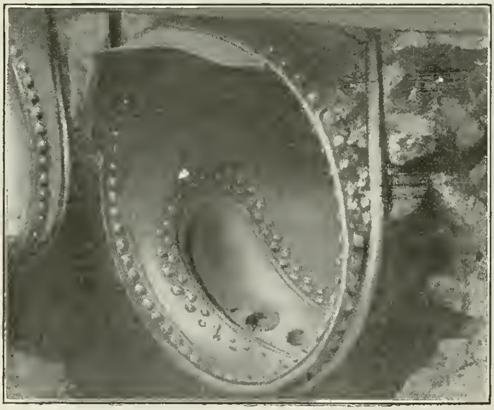


FIG. 1. END OF STEAM DRUM, HEAD BLOWN OUT

The fracture was not continuous through the rivet holes, but followed an irregular line in some cases, leaving considerable metal around the rivets. Chiefly, however, the crack followed along the line of the rivets. It appears that the fracture in the head had existed for some time.

A number of boiler explosions have occurred in which cracks have been discovered from rivet holes to the surrounding plate, or from rivet hole to rivet hole, or from rivet holes to the edge of the plate. The development of these cracks usually occurs below the water line and generally in conjunction with a leak, and the deterioration of the boiler metal may be due to the embrittlement of the steel, resulting from caustic soda used in the feed water. It is possible that the boiler head under discussion contained fine cracks, as has been found in other instances, due to the presence of caustic soda, which will, if of sufficient strength, attack iron with the generation of hydrogen.

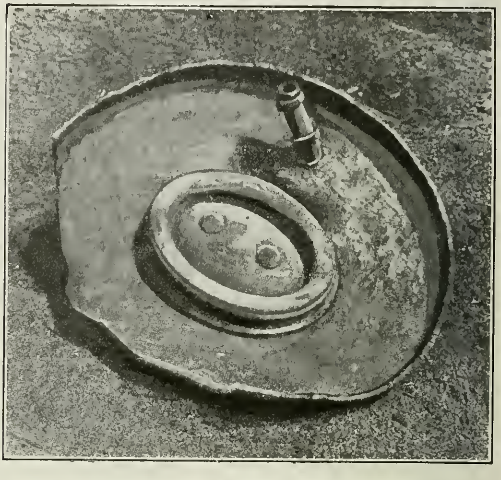


FIG. 2. VIEW OF DRUM HEAD, SHOWING FRACTURE

Workmen's Compensation Act Applied

The Pennsylvania Workmen's Compensation Act provides for the payment of awards on account of injuries to employees by accident in the course of their employment and while actually engaged in the furtherance of the business of the employer.

In the recent case of Messer vs. Manufacturers' Light and Heat Co., 106 Atlantic Reporter, 85, it appeared that plaintiff's husband was employed by defendant as engineer in a pumping plant. At the request of his superintendent he went to inspect another pumping station with a view to increasing his efficiency. On his way homeward from this trip he was fatally injured in an automobile accident, and his widow applied for allowance of an award under the Compensation Act.

The application was resisted, but the Pennsylvania Supreme Court holds that plaintiff was entitled to recover, on a theory that at the time of the accident he was acting within the scope of his employment and in furtherance of his employer's interests, although not then actually engaged in operating the defendant's pump.

EDITORIALS

Gas-Steam Engines

A GAS-STEAM engine, named after its inventor, the Still, has been tested in England under the supervision of Prof. C. Vernon Boys, F.R.S., and is described in this issue. The engine utilizes steam generated from the heat now lost to the water jacket and exhaust.

The gas-steam engines at the Ford plant in Detroit are well known. The heat in the exhaust gases is taken out by a superheating receiver between the high- and low-pressure cylinders of a steam engine, and by a feed-water heater. The jacket water is used as boiler feed.

Power has previously suggested that, when the process of combustion under pressure is perfected, an engine taking alternate charges of steam and gaseous products of combustion under pressure would appear to offer a solution of the problems of both the steam and the internal-combustion engine. The problem with the steam engine is to keep the interior surfaces of the cylinder hot. The entering steam comes in contact with surfaces chilled by exposure to the exhaust of the previous stroke and by the evaporation of moisture from them during the exhaust stroke. The problem with the internal-combustion engine is to keep it cool, and something like one-third of the heat supplied goes off in the jacket water.

If a generator were practicable in which fuel were burned under pressure, so that the products of combustion could be used like steam in an engine cylinder, such a gas might be used for a stroke or two and then a stroke or two made with steam of the same pressure. The steam would find the cylinder bone dry, initial condensation would be avoided, and the relative use of the gas and steam could be so proportional as to keep the cylinder from heating above a safe temperature or from getting below the initial temperature of the steam.

Was Caustic Soda Responsible?

TWO explanations have been offered for the boiler explosion at Newmarket, Ontario, recorded in this issue: One that the initial failure occurred in the equalizer-pipe connection, the release of pressure, with the accompanying water-hammer effect in the drum blowing out the weakened head; the other, that the break in the pipe was secondary and that the failure occurred first in the head.

Either may have been correct, but it is conceded that the head was in a weakened condition. It is significant that the failure followed the line of rivet holes below the water line, and tore through the solid metal well up in the bumped portion above the water line. This indicates that the metal was weakened, apparently below the water line only, and precludes the theory that breathing action of the head might have been responsible; for in all such cases the failure has been completely around the knee of the flange, with greatly reduced thickness of metal in this region.

It would appear in the present case that the metal was brittle along the line of rivets or that there were cracks in this section, or perhaps both. We are told by one who saw the boiler recently that, although it withstood the hydrostatic test satisfactorily, when under steam leaks were observed around the flange of the head and that this section was coated with salts.

This points strongly to the embrittling action of sodium hydroxide.

It will be recalled that the engineering experiment station at the University of Illinois about three years ago made some investigations into the effect of caustic soda on steel in boilers and published the findings in Bulletin No. 94. The conditions that led up to the investigation were a number of head failures, all below the water line, in connection with leakage at seams and rivet holes and accompanied by an exterior accumulation of incrustation of a strongly alkaline character. In all these cases the water employed contained a considerable amount of caustic soda.

The investigation, although not carried to conclusion, indicated that caustic soda of sufficient strength attacks the metal, liberating hydrogen in the nascent state, which in turn affects the physical properties of the metal and produces brittleness.

Information is not at hand as to the character of the water used in the Newmarket boiler. Further discussion may throw more light on the matter. It is a problem close to many engineers and will bear considerable investigation.

Protection of Electric Motors

UNLESS electric circuits are properly protected, the equipment connected thereto cannot perform the duties for which it is designed, or else it is liable to serious damage in case of trouble, and the whole electrical system becomes a hazard to both life and property. Fuses were the earliest device employed to automatically open electric circuits in cases of emergency. These devices still have a wide field of application where they give sufficient protection to electric motors. One of the places where the fuse gives best protection is in direct-current motors that start under ordinary conditions and are not subjected to heavy overloads for any appreciable length of time, of which there are a vast number in use. In general the starting resistant of direct-current motors is designed so as to limit the current inrush at starting to about one hundred and twenty-five to one hundred and fifty per cent. of full-load current. This allows fusing the motor at about one hundred and twenty-five per cent. full-load rating, and the time lag of the fuse is sufficient to take care of momentary overloads. With an overload of one hundred per cent. on the motor and the circuit fused for one hundred and twenty-five per cent. of the motor's rating, the fuse will open the circuit in approximately thirty seconds, which is sufficient time for the cause of the overload to be removed, or the motor should be disconnected from the circuit, unless able to take care of heavy overloads for longer periods than the standard motor is designed for. To protect the motor under the latter condition a circuit breaker having an inverse time element is required, adjusted to the overload that the motor is capable of operating under.

In the protection of polyphase motors two elements have to be contended with: namely, protection against overload from external sources and also single-phase operation, the latter causing the active phase to be overloaded if the machine is operating near normal load under polyphase operation. On account of the large starting current required by squirrel-cage-type induction motors, even under normal conditions, it is almost impossible to fuse the circuit so as to protect the motor during the starting period and also under operating conditions. The starting current, ranging as it does from three hundred to six hundred per cent. normal full-load value, leaves little opportunity of fusing a circuit to protect the motor against abnormal condition while running, if the starting period is of appreciable length, as is the case when starting heavy inertia loads. This has been met with the use of fuses in two ways. One is by having the fuses in the circuit only while running, which leaves the motor without any protection while starting, except the main fuses on circuit-breakers, which to say the least is objectionable. In the other method two sets of fuses are used, one in the starting circuit and the other in the running circuit. Of course, when the latter is used, the first cost begins to approach that for which overload relays, having an inverse-time element, can be installed. The relays will give complete protection to the motor both against overloads and also single-phase operation, except in extreme conditions which have to be taken care of by special means.

In an article in this issue O. C. Callow discusses the various types of protection for electric motors that are in common use. In his conclusion he points out that a study should be made of the conditions under which the equipment will operate when installed, and the best type of overload protection should then be selected to meet the condition. This, no doubt, is the best solution of the problem, so far as the installation is concerned. But after this is done there is the human element that must be considered in the operation, which no doubt causes more apparatus to be destroyed than improper choice of protection. There is little use of installing proper protective devices, whether they be fuses, inverse-time limit relays or what not, if the proper adjustments are not maintained. If the circuit is properly protected and some condition arises that causes the device to open frequently, the proper remedy is not a large or improperly filled fuse or a higher setting on the relays, or circuit-breaker; yet this is what is frequently done, especially where motors are cared for by incompetent attendants and the real cause of the difficulty is not located and remedied. It is this practice that is causing probably more failures of apparatus than anything else. Both fuses and other types of overload equipment have their respective field of application in the protecting of electric motors. However, so far there is not available what would be an ideal protection for electrical equipment—one in which the time of opening the circuit is a direct function of the heating of the motor, since as long as the motor does not reach a dangerous temperature, there is little reason for disconnecting it from the line. When such a device is available for all sizes of machines, considerable advance will have been made in the protection of electric motors.

Resuscitation from Electric Shocks

THE supplement "Resuscitation from Electric Shocks," published in this issue is a chart giving instructions for resuscitation from electric shocks by the "Prone-Pressure Method," as recommended by the Commission on Resuscitation from Electric Shocks, representing the American Medical Association, the National Electric Light Association and the American Institute of Electrical Engineers. This method of artificial respiration is equally applicable to resuscitation in all cases of suspended respiration due to drowning, inhalation of gas, smoke or fumes, as well as from electric shocks. The chart is an abbreviation of the booklet of rules for resuscitation from electric shocks, as revised by the National Electric Light Association. W. C. L. Eglin, chairman of the committee on Safety Rules and Accident Prevention of the N. E. L. A. in the preface to the booklet of rules, says:

> The revision of the rules and also the chart, which consists of an abbreviated form of these rules, has been based on field experience covering a number of years; and while no very radical changes have resulted, changes in detail have been made, which, it is felt, will make the operation of the method more effective and to which the careful attention of instructors and those familiar with the method is directed.

No power plant is too small to have someone trained in this method, and it is hoped that the publication of this supplement will cause the adoption of this means of artificial resuscitation in many plants, where at the present time means of resuscitation from electric shocks or otherwise is entirely lacking. To say the least, the committee has done a great humanitarian work in presenting these rules in so simplified a form; however, it remains for those in authority in the industrial establishments and electric-power systems to make them effective.

One going through engineering publications would get the impression that the steam reciprocating engine was on its last legs and about to become as rare as a diplodocus. Nothing is more preposterous. The steam engine has a wide field of application and will continue to be widely used. *Power* wants more articles on the reciprocating engine, articles of the practical kind particularly. They are more acceptable if short, of not more than a thousand or fifteen hundred words, and well illustrated by plain sketches and photographs. Let us have more articles that treat of its operation, care and maintenance.

In one of the discussions at the spring meeting of the American Society of Mechanical Engineers, a story was told of a test which showed an impossible performance. Careful checking of the log failed to reveal any discrepancy in the figures, the observations were uniform and consistent but the efficiency was unbelievable. Inquiry finally fastened upon the venturi meter with which some of the quantities were measured. "Oh that," said the engineer. "Yes, we had trouble with that at first, but I bored out the little passage in the middle, and it has worked fine ever since."

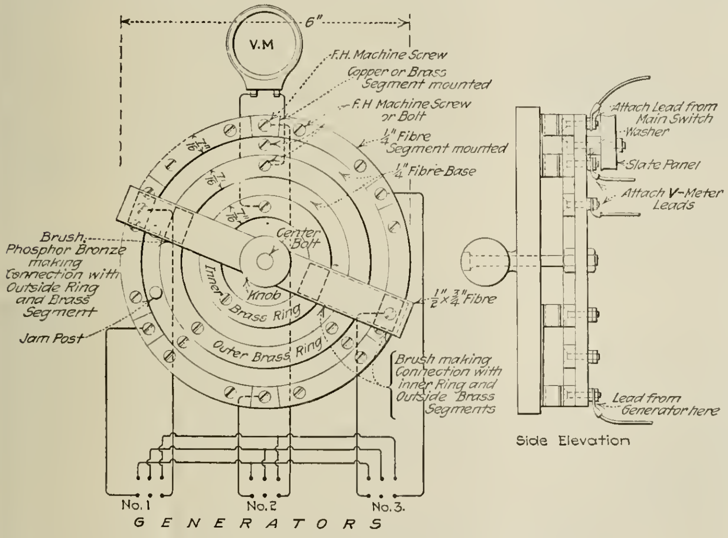
It is not so many years ago that a movement was started for the enactment of laws to limit the voltage of electric circuits to about 1000 volts. At the present time the indications are that the 220,000-volt system is a realization of no distant future.

· Correspondence ·

An Inexpensive Voltmeter Switch

A voltmeter switch that I designed and have had in use for two years at two plants where we have three generators working in parallel is shown in the illustration. It is rather an expensive matter to have a voltmeter for every circuit, and as most people practice economy differently, there are many kinds of voltmeter switches on the market and very few good ones. It isn't the principle that gives the trouble; it is the switch.

My switch overcomes some of the objections found in so many types of switches, such as the following: The liability to injury from careless handling; liability to loosen and turn around; liability of contacts to get out of line and sieze; liability to spread a film of dust or metal from segment to segment and cause a short-circuit; liability to collect dust in pockets and destroy electrical connection in places; electrician's weakness.


6"
V.M
F.H. Machine Screw
Copper or Brass Segment mounted
F.H Machine Screw or Bolt
1/4" Fibre Segment mounted
1/4" Fibre-Base
7/16
7/16
7/16
Center Bolt
Brush, Phosphor Bronze making Connection with Outside Ring and Brass Segment
Jam Post
Knob
Inner Brass Ring
Outer Brass Ring
1/2" x 3/4" Fibre
Brush making Connection with inner Ring and Outside Brass Segments
No. 1
No. 2
No. 3.
GENERATORS
Attach Lead from Main Switch
Washer
Slate Panel
Attach V-Meter Leads
Lead from Generator here
Side Elevation

PLAN AND SIDE ELEVATION F VOLTMETER SWITCH

In using my voltmeter switch there is no cause for anxiety about the calibration of the meter when two or three machines are thrown together for the same meter will be used for both and all machines. It is rather inexpensive to make, as the only machine parts are the two brass rings and the round fiber base on which the segments and rings are mounted. The plan view shows the connections for three generators. The three short segments can be marked No. 1, 2 and 3 generator respectively so as not to cause any confusion in reading. The two brushes are always in contact with the rings, and it is impossible for arc to carry from one short segment to another on account of their distance apart.

Linton, Ind. JOHN J. NOLAN.

Lignites and High-Moisture Fuels

Having read with much interest the article "Combustion of Lignites and High-Moisture Fuels," by T. A. Marsh, on page 525 of *Power* for Apr. 8, I would very much like to see published figures of actual tests that were made in Alberta on Alberta lignite with chain-grate stokers (Green or others) whose furnaces are the same as those shown in the illustrations of the article mentioned.

Having had much experience with chain grates in burning lignite from various parts of Alberta, I must admit that I do not consider that any of the types of furnaces shown would be very successful here. Personally I have had the best success with the arches exactly reversed, the short arch nearest the coal hopper and the long (ignition) arch extending from at or near the bridge-wall toward the short arch. This method will bring the heat farther forward and reflecting on the incoming coal as it leaves the hopper will assist greatly in driving off the moisture and in igniting the fresh coal. In this plant we were unable to burn lignite slack at all on the chain-grate stokers until we had put in arches in the way I have mentioned.

This type of arch has been adopted by the power plants at Calgary, Lethbridge, Saskatoon (Saskatchewan), and I think Moose Jaw now has them. Knowing that the principal power plants in Alberta that are operating on lignite have their arches the reverse of those shown in the article I am referring to and having found from my own experience that this was necessary, I should like to get in touch with someone who is using the type of furnace shown in the article under discussion operating on Alberta lignite, as I am ready to adopt any method by which the best results can be obtained.

Fresh coal just deposited on the grates from the hopper will not ignite till the moisture has been driven off by the heat of the furnace and will tend to cool off the front arch until it (moisture) has been heated to a high temperature, and it stands to reason that the sooner that is done the less the front arch will be cooled and the sooner ignition will take place, so the farther forward the hot burning gases are brought by the ignition arch the greater will be the heat on the fresh coal. I would be pleased to read the views of others on this subject. C. F. COPE.

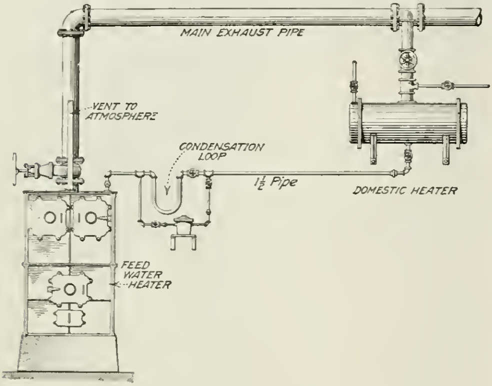
Edmonton, Canada.

No Safety Valve on Domestic Heater

The heating equipment of a large commercial and office building, as originally installed, included a small low-pressure heater, consisting essentially of a cast-iron shell containing a set of circulating coils as a supplementary source of hot water for a limited area in the building. This heater was connected between the main-engine exhaust pipe and the feed-water heater, as shown in the illustration. The loop in the pipe running to the feed-water heater served as a condensation trap to keep the steam from blowing directly through.

Eventually, the heating and electrical requirements of the building came under central-station service. Under this method of operation the engines were shut down during the summer months. It was necessary, therefore, to make a live-steam connection to the small heater in order to keep the hot-water service going during this interval. Since a high-pressure steam connection to an apparatus only strong enough to sustain ordinary exhaust pressure naturally calls for a pressure-reducing valve, one of these valves was installed. But it was an old valve long past its days of usefulness, and it did not work very well. The attendant might set it to get enough steam through to heat the water satisfactorily, but when he would go back after awhile to take a look no steam would be going through. He would then pick up a piece of scrap iron, a lump of coal, a monkey wrench or whatever appeared to be about right, and hang it on the regulating lever of the valve; whereupon the steam would again start simmering through. Presently there would be a great commotion inside the feed-water heater, the regulator having gradually responded to the added weight and allowed a full current of high-pressure steam to blow through. This, however, was not particularly dangerous, since the atmospheric vent from the feed-water heater was ample to keep the pressure from accumulating.

The pressure regulator got to be such a nuisance that it was discarded and an ordinary globe valve put in its place. This was not such a bad idea. The attendant could crack the valve just enough to let in the needed quantity of steam; but if through inadvertence the valve was ever opened too much, the outlet to the atmosphere would keep the pressure from rising high enough to blow up anything; and anyway the price of regulator reducing valves about that time was away up.



SHOWING PIPING OF THE DOMESTIC HEATER

Eventually, the engine plant in the building was abandoned altogether, the operating company having made provision for supplying steam for heating purposes directly from a central boiler plant. Also, about this time a number of condensation meters were installed. As the abandoned feed-water heater was pressed into service as a tank for receiving the discharge from the meters, it was essential that no undue pressure be created therein, as might be the case if the drain connection from the domestic heater remained as originally installed. It was determined, therefore, to connect in a steam trap, as shown.

This arrangement worked very well while the little heater held out. But that was a distressingly short time. The heater was at an elevation about midway of a stairway that ascended near-by. As the engineer was walking up the steps one morning the inevitable happened—the little heater was blown to fragments. The engineer was badly cut and scalded as a result of the accident.

A reliable relief valve on that heater would have insured the nearest possible approach to safety. It is probable, however, that the operating company had no suitable safety valve lying around unused when they decided to bottle up the domestic heater with a high-pressure steam trap. Furthermore, if the globe valve in the steam-supply pipe was always kept adjusted just so—and it was confidently assumed that the attendant would do that very thing—there would be no need for a relief valve. At any rate there was no safety valve on the heater. **A. J. Dixon.**

St. Louis, Mo.

Fumes from Oil-Engine Exhaust

Several months ago we installed a 20-hp. semi-Diesel engine, running at 235 r.p.m. The exhaust enters into a muffler tank and from there escapes to the atmosphere. No complaints were received during the cold winter months, but lately, since surrounding factories have opened their windows, protests have been coming in about the gases from the exhaust of our engine causing sickness among the help, and we have tried in various ways to remedy the matter, but so far without success.

One method tried was to carry a 4-in. exhaust pipe from the muffler tank up two stories so that the exhaust from the engine was above our roof. At times the exhaust appears to be clear and practically without fumes, and at other times the gases seem to settle near the ground, hence the cause for complaint. The extension of the exhaust pipe does not seem to have remedied matters.

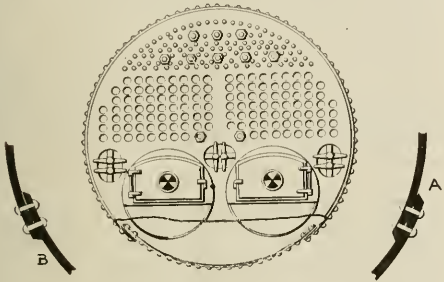
We tried putting on a muffler in which water was sprayed, but the muffler was blown to pieces; probably it was too small for the pressure exerted by the exhaust gases from the engine.

Of course, we desire to abate the nuisance to those who are located in our vicinity, and I would appreciate any information that gas engineers may have regarding the treatment of gases from the exhaust of engines. Probably some of the readers of *Power* have had experience along this line, and can give information that will be of assistance. **G. R. Thomas.**

Albany, N. Y.

Why Does One Seam Groove More Than Another?

As is well known, grooving at the longitudinal seams of lap-seam boilers has been the cause of many serious boiler explosions. As a boiler inspector, I have noticed, however, that much (I might say everything) depends on the lay of the plate at the seam. With a lap seam having the plates arranged as shown at *A* I have never yet found a case of grooving, whereas if arranged as shown at *B*, grooving can often be found in all stages. Why should this be? I have asked several engineers, but have had no satisfactory explanation. Can any reader answer the question? This applies to what is known as the Lancashire or Cornish boilers which are in general use in this country. The grooving is usually to be found when the seam is toward the bottom of the boiler.



SHOWING TWO TYPES OF RIVETED JOINTS

A. BENNETT.

Wigan, Lancashire, England.

Losses in Belt Transmission

Comparatively little attention is given to the economic and efficient transmission of power by belt from prime movers to productive machines. There are two factors of loss in belt transmission that are equal to, if not greater than, any two factors of loss in power production; namely, excess tension and belt slip. The first is a source of lost power and increased cost of maintenance, and the second results in lost power, loss of production and increased maintenance cost.

In a well-conducted power plant a slight steam leak receives immediate attention because it advertises itself and its existence reflects discredit on the man in charge. But a much greater loss from slips or excess tension may continue indefinitely and receive no attention. In fact, its existence may not even be suspected.

The traditional practice of increasing the tension to reduce the slip does not materially reduce the loss. It simply shifts it from loss of production through slip to loss of power from excess tension. If the statement that "each 1 per cent. of slip means a loss of 1 per cent. of power" were changed to "each 1 per cent. of slip means a loss of 1 per cent. of production," a more accurate idea of the loss would be expressed. If the loss through slip is converted into a loss of time, then each 1 per cent. of slip means a loss of 1 per cent. of the operating time, and hence a loss of three days in each 300-day year. Since the loss through slip, under ordinary conditions, ranges from a minimum of 5 per cent. to more than 15 per cent., we are confronted by a minimum loss of 15 days' production each year. Thus, where operating expenses are $100 a day, a yearly tax of $1500 is paid on inefficiency and traditional belt care. Add to this the loss of power from excess tension, and the bill becomes considerably larger.

In a mill in which a fan was driven from a motor by a 4-in. double leather belt, under dusty conditions, the tension of the belt was regulated by observing the reading of the ammeter. This was kept at 22 amperes, the impression being that the efficiency of the fan depended on the power used as indicated by the meter.

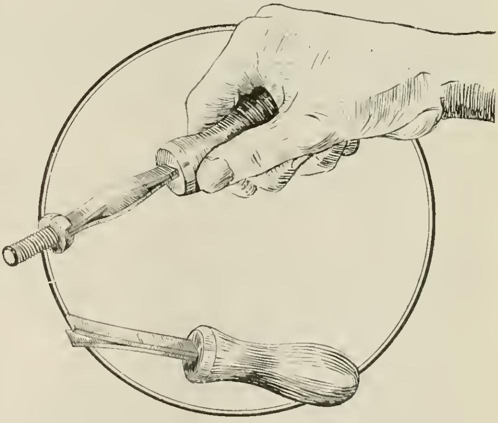
Under the direction of another superintendent tests were made which showed that with this high tension the loss through slip was from 7 to 12 per cent. The belt was thoroughly cleaned, repaired and adjusted until it was just tight enough to run steadily. The slip under these conditions was from 2 to 5 per cent., while the meter showed a steady reading of 9.1 amperes at 440 volts. Thus, more than 1.4 times the power necessary to do the work was wasted in overcoming excess friction due to high belt tension, with correspondingly high maintenance cost.

This is an extreme case, yet it existed under a superintendent who is an apostle of efficiency and an excellent executive, but who followed traditional practice to an extreme degree. When these two factors—excess tension and slip—are given the attention they deserve, transmission costs will be greatly reduced. How many superintendents know from actual tests their losses through slip and excess tension?

Tyrone, Penn. J. FRED ENGLER.

Handy Screw Holder

It is sometimes inconvenient to start a small screw into a hole when it is impossible to start it with the hand. A handy screw holder can be made by placing two pieces of spring steel in a handle, as shown. Then, by pressing the two open ends together and putting them in the screw slot, the tendency of the ends to open will hold the screw and it can easily be started in the hole and then tightened with the ordinary screw driver.



SCREW HOLDER AND ITS APPLICATION

WILLIAM H. WATSON.

Norristown, Penn.

More Efficient Power-Plant Operation

I have been interested in the descriptions and drawings of the United States Nitrate Plant No. 2, at Muscle Shoals, Ala. The article in the May 27 issue was especially interesting as it gave the heat balance for the station and the expected economies that should prevail in future operation. The figures show remarkably low coal consumption. To actually produce these results is another matter. It will require an A-1 organization from top to bottom, and the combined teamwork must be perfect. This is where many such stations "fall down." Notwithstanding the fact that power plants are presumably designed and built to operate at maximum economy, the operation usually suffers from a lack of understanding. This is largely because the management greatly underestimates the skill required to get the best possible results obtainable.

The recent nation-wide experience in war activities has taught many valuable lessons. One of these, and a very important one, is more efficient power-plant operation. This must and will come. Some of the managers will have to shed some of their antiquated ideas. Labor costs will no doubt rise, but the final kilowatt-hour cost will go down to a point somewhere near where it should be and stay there. The final cost is the real thing. **CHARLES A. CAHILL.**

Milwaukee, Wis.

Proportioning Fuel Economizers

With reference to A. B. Clark's article on "Proportioning Fuel Economizers," in the Apr. 22 issue, I heartily agree with him that the operating characteristics of economizers are destined to become of increasing interest in the near future, considering the rise in boiler pressures and boiler ratings, and also the high price of fuel.

He has, however, made use of a lengthy and not exactly accurate method of figuring results which can be obtained by shorter means. I have worked out the following formula for parallel flow and counterflow, giving relations between incoming and outgoing gas and water temperatures and heating surface:

Parallel flow,

$$S = - \frac{W c_p g}{f(1 + c_p g)} \log_e \left[\frac{T_2 (1 + c_p g) - (t_1 + c_p g T_1)}{T_1 - t_1} \right]$$

Counter flow,

$$S = - \frac{W c_p g}{f(1 - c_p g)} \log_e \left[\frac{T_2 - t_1}{c_p g (T_2 - T_1) + (T_1 - t_1)} \right]$$

in which

S = Total heating surface, sq.ft.;
W = Flow of water, lb. per hour;
T_1 = Incoming gas temperature deg. F.;
T_2 = Outgoing gas temperature deg. F.;
t_1 = Incoming water temperature deg. F.;
c_p = Specific heat of gas, B.t.u. per lb. per deg.;
g = Gas flow, lb. gas per lb. water;
f = Rate of heat transfer — B.t.u. per sq.ft. per degree difference per hour.

$\log_e$ means logarithm to base e or natural logarithm.

The negative sign may look queer, but it will be noted by use of the formula that this cancels out since the logarithm of the term in brackets is negative. Also it must be noted that the formula is based on zero radiation loss, and that the heat-transmission factor must be properly assumed with reference to velocity of gas and water flow, etc.

Using Mr. Clark's two sets of assumed conditions the formulas give the following results:

W = 100,000 lb. per hr
T_1 = 600 deg. F.
T_2 = 340 deg. F
t_1 = 100 deg. F
cp = 0.24
g = 12.25/6.3 = 1.945
f = 5.5 B.t.u. per hr per sq ft per degree difference
Conditions same as above except—

t_1 = 150 deg. F
g = 12.25/6.55 = 1.87

Parallel flow
S = 8,370
Mr. Clark's figure, 8,250

Counterflow
S = 7,260
Mr. Clark's figure, 7,300

Parallel flow
S = 10,220
Mr. Clark's figure, 10,250

Counterflow
S = 8,330
Mr. Clark's figure, 8,350

The rise in water temperature may of course be obtained directly from the drop in gas temperature, specific heat of gas, and ratio of gas to water.

Lorain, Ohio. **C. C. COBB, JR.**

Enlightening Electrical Answers

The following answers taken from a quiz, given at one of our barracks, to a bunch of aspiring Edisons, may be of interest to your readers.

Ohm's law is a law laid down by the states to prevent electrical fires.

The safety limit of any size conduit is, fill it so that air can't circulate and cause shorts.

A bridging telephone line is one that connects three or more farmers.

A series line is one that connects less than two more than one.

Edison discovered the storage battery from a pet cat.

Kilowatts are units, the size of which are regulated by law, that come out of generators.

Transformers are instruments for making soft and pleasing lights for household use. They are not used on street lights because in that case they need a sharp penetrating light.

High-tension lines are ones that are pulled tighter than low-tension lines.

A storage battery can be charged on alternating current by reversing the leads at each cycle. (This is undoubtedly true.)

Electrolysis is the system used by undertakers for cremating bodies. **A. W. KIRBY.**

Baldwin City, Kan.

Simple Trap Telltale

On asking the chief engineer of a plant I was visiting, the reason for the blowing of a small whistle, I learned something that may be of use to the readers of *Power*.

In this plant they have a return trap that is on very exacting duty. For fear that it might hang up after discharging, a whistle was attached to the trap so that it would blow when live steam was admitted. If the whistle continued to blow when the trap discharges, the man on watch knows that the trap is hung up and wasting steam. If the whistle is not heard at the regular intervals, the engineer knows there must be trouble brewing and can make an investigation before sufficient water has accumulated to do any harm.

New Bedford, Mass. **H. K. WILSON.**

If a shaft extends beyond the bearing housing, it should be protected by a proper covering.

Inquiries of General Interest

Splitting of Sheet at Rivet Holes of Girth Seam—What causes cracks from the rivets to the edge of the sheet in the girth seam of a horizontal return tubular boiler, immediately over the fire? H. M.

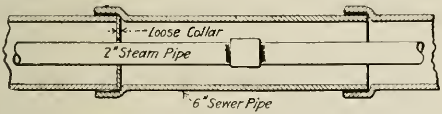
The texture of the material may have been injured in the construction of the boiler from driving drift pins or from setting the rivets too cold, but more often, splitting at the edge of the sheet is due to expansion of the rivets from becoming overheated, especially when there is scale in the boiler.

Pressure Available from Steam Line—A 2-in. steam line supplies steam to a dry room from a boiler that carries steam at 100 lb. pressure and the line is extended beyond a dry room branch to supply steam to three pumps. Is it possible for the pumps to be supplied with steam at full pressure or for the pump at the end of the line to obtain as much steam as the others? J. M.

When any steam is drawn from or condensed in a pipe line the line pressure cannot be as high as boiler pressure, because drop in pressure is a necessary accompaniment of flow or condensation. It is therefore impossible for the pumps to be supplied with steam at the full boiler pressure and the greater the draft of steam between the boiler and a branch out of the line the lower the pressure in the line at the point where that branch is taken off. When steam is supplied to any other branch, the line pressure that is available for the branch to the pump at the end of the line cannot be as great as the line pressure available to a pump or any other branch that is taken out of the line nearer the boiler.

Underground Conduit for Steam Pipe—It is desired to put down a 2-in. underground steam line about 200 ft. long for heating purposes. The pressure of steam delivered to the line will be 15 lb. What method of conduit construction is recommended where the soil is sand and clay? R. J. B.

A good conduit for 2-in. underground steam pipe can be made of 6-in. sewer pipe, as shown by the sketch. The steam pipe is held centrally in the sewer pipe by iron washers that are like loose collars on the pipe. The outside diameter of the iron washers is the same as the outside diameter of the sewer pipe and the washers are placed at joints that are about six feet apart. The space around the steam pipe can be filled with loose insulating material or left as an air-space insulation. The top and sides of the sewer-pipe joints can be made up with cement in the usual manner, but to take care of any water that may find its way into the conduit the under side of the joints should be left unsealed with provision for the subsoil drainage.



Height of Raising Water by Return Trap—How high will a return steam trap raise water? D. M.

The height depends on the density of the water, the pressure of steam acting on the water for expelling it from the trap, the back pressure or pressure ahead of the water, and the pressure required for overcoming friction of pipes, valves and fittings. The density of water at 62 deg. F. is 62.36 lb. per cu.ft., and as a column of water at that temperature and one foot high would exert a pressure of $62.36 \div 144 = 0.433$ lb. per sq.in. for each pound pressure of steam in excess of back pressure and pressure required for overcoming friction, the water could be raised to a height of $1 \div 0.433 = 2.309$ ft. At 200 deg. F. water weighs 60.07 lb. per cu.ft., and without allowance for back pressure and pipe friction, for each pound pressure of steam acting on the surface of the water it could be raised to a height of $1 \div (60.07 \div 144)$ or $144 \div 60.07 = 2.397$ feet.

Lower Compression Due to Higher Vacuum—Why do indicator diagrams from the low-pressure cylinder of our compound condensing engine show less compression of the exhaust for $28\frac{1}{2}$ than for 26 in. condenser vacuum, without change of the engine valve setting? A. H.

The absolute pressure represented by $28\frac{1}{2}$ in. vacuum would be $30 - 28\frac{1}{2} = 1\frac{1}{2}$ in. mercury-column pressure, and for 26 in. vacuum would be $30 - 26 = 4$ in. mercury-column pressure. Hence, with the exhaust closing at the same fraction of stroke, compression of the exhaust with $28\frac{1}{2}$ in. vacuum would be only $1\frac{1}{2} \div 4$ or $\frac{3}{8}$ as high in absolute pressure as for 26 in. vacuum.

Volts Drop in Power Line—If 250,000-circ.mil conductors were used to transmit 800 hp., having a power factor of 0.80, 8000 ft., at 2200 volts, on a three-phase 60-cycle system, with the conductors spaced in a triangle 24 in. apart, what would be the volts drop in the line? G. G.

The volts drop in a three-phase circuit may be calculated in the same way as for a single-phase circuit transmitting one-half the load. Therefore, in this problem, find one-half the three-phase load in amperes and proceed as if calculating a single-phase circuit. One half the single-phase watt $W = \text{hp.} \times 746 \div 2 = 800 \times 746 \div 2 = 298{,}400$ and the current I.

$$I = \frac{W}{E \times P.\ F.} = \frac{298{,}400}{2200 \times 0.80} = 170 \text{ amperes.}$$

The volts drop in the circuit is made up of two parts, one the resistance component and another the reactance component. If E_R is let to represent the volts drop due to the resistance of the conductors and E_X the volts drop due to the reactance of the circuit, we have

$$E_R = \frac{2LIR}{1000}$$

Where L equals length of conductors in feet one way and the R resistance per 1000 ft. of conductor; and

$$E_X = \frac{2LIX}{1000}$$

where X equals the reactance drop in volts per ampere per 1000 ft. of conductor at 60 cycles, conductors spaced 24 in. apart; as obtained from a table $X = 0.110$. Then

$$E_R = \frac{2 \times 8000 \times 170 \times 0.042}{1000} = 114.24 \text{ volts}$$

and

$$E_X = \frac{2 \times 8000 \times 170 \times 0.110}{1000} = 299.2 \text{ volts}$$

The volts drop in the line is

$$E_L = \sqrt{E_R^2 + E_X^2} = \sqrt{114.24^2 + 299.2^2} = 320.3 \text{ volts}$$

This is equivalent to $320.3 \div 2200 = 14.55$ per cent. drop, which is considerably higher than would be considered good practice.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—**Editor.**]

Combination Internal-Combustion and Steam Engine of High Efficiency

In a paper read recently before the Royal Society of Arts (England) and abstracted here, Frank E. D. Acland described a combination internal-combustion and steam engine developed by W. J. Still, in which the products of combustion act on one side of the piston and steam on the other, the steam being generated largely by the waste heat from the gas cycle.

THE maximum ideal efficiency of a heat engine is obtained where the difference existing between the highest and lowest temperatures of the working fluid is greatest in proportion to the maximum temperature, and here the ordinary internal-combustion engine, with an initial temperature often higher than the furnace temperature of the boiler is capable of realizing better thermal conditions than any other form of heat engine; but in its turn it suffers from two disadvantages—it ejects its working fluid at a temperature too high for ideal conditions, and it loses heat energy to a regrettable extent in the cooling of its cylinder. In existing engines some proportion of the heat can be usefully recovered as steam from the exhaust gases, but the cooling water from the jacket is of little value, owing to its low temperature, and the efficiency of the engine itself is not augmented. If, however, the temperature of the cooling water could be maintained at that of steam at useful pressure, the efficiency of the engine would be improved and the weight of steam be usefully increased. This is accomplished in the engine developed by W. J. Still.

The Still engine is an engine capable of using in its main working cylinder, any form of liquid or gaseous fuel hitherto employed; it makes use of the recoverable heat which passes through the surfaces of the combustion cylinder, as well as into the exhaust gases, for the evaporation of steam, which steam is expanded in the combustion cylinder itself on one side of the main piston, the combustion stroke acting on the other side. It increases the power of the engine and reduces the consumption of the fuel per horsepower developed.

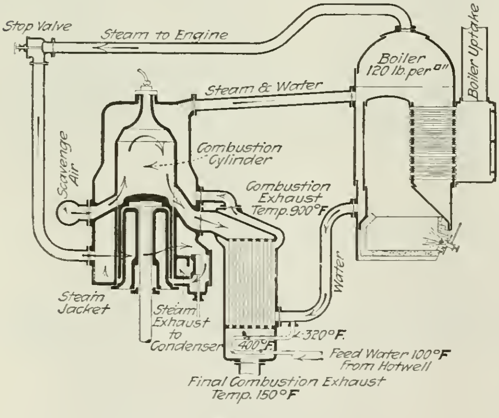


FIG. 1. CROSS-SECTION DIAGRAM OF STILL ENGINE

Its primary object is not to use the waste heat for raising steam, but first to use it in improving the thermal conditions of the working cylinder, and so insure the maximum efficiency from the fuel burnt within it, diminishing, as a consequence, the heat lost in that operation. Since the maximum efficiency is obtained by combustion of the fuel in the cylinder and the minimum by the evaporation of the water in the steam generator, it is evident that the larger the quantity of steam that can be generated per horsepower developed by the combustion cycle, the lower must be the heat efficiency of the whole machine.

In the Still engine (Fig. 1) the jacket and cooling water form part of the circulating system of a steam generator, which may be an integral part of the engine or external to it. The cooling water therefore enters and leaves the jacket at a constant temperature, regulated by the pressure of steam, the cooling being effected by converting the water into steam without raising its temperature. Excluding the radiation losses, which are kept low by lagging, all the heat which passes through the walls is thus usefully recovered in the water as steam. The temperature of the cylinder wall is uniform over the whole of its exterior surface, and the heat lost to the cooling water at each stage of the cycle—compression, combustion and expansion—is diminished.

During compression, owing to the walls being at steam temperature, the incoming charge picks up heat, instead of losing it, during the greater part of the stroke, an advantage of the greatest value to the heavy-oil types of Still engines, where an air charge is taken in at the full outstroke, and is compressed to a pressure where its increased temperature insures the certain ignition and combustion of the fuel that is injected into it.

During combustion and expansion the uniform and higher mean temperature of the walls reduces the heat lost to the jacket water. Some of the heat thus economized adds to the useful work on the piston, the rest passing out in the exhaust gases for recovery.

To insure the maintenance, in a practical and reliable manner, of the temperature conditions that produce this efficiency during the combustion cycle, a departure from the design and construction of the cylinders of normal internal-combustion engines is imperative; they have hitherto been made of cast iron, of a thickness sufficient to resist the working and thermal stresses thrown upon them, including occasional heavy loads caused by preignition of the explosive charge. With these thick walls or liners, the temperature difference between their inner and outer surfaces, which is essential if the surplus heat is to be carried off, can be obtained safely only by the circulation of water at low temperature through the jacket; this is especially the case in cylinders of considerable diameter or capable of high power per swept volume.

The cylinder of a Still engine consists of an inner liner, which is approximately one-third to one-fourth the usual thickness; it is ribbed externally so as to add to its conducting surface and provide suitable passage for the cooling water, and it is reinforced by an outer hoop capable of withstanding the highest pressures to be met with in working. The stresses due, in ordinary practice, to the cold water at the inlet, and the hotter water at the outlet, are suppressed in the Still cylinder, the cooling water being at a controlled and uniform temperature throughout.

STEAM FROM WASTE HEAT

In gas and oil engines of constant-volume and constant-pressure types the combined losses in radiation—cooling water and exhaust gases—range between 75 per cent. and 65 per cent. The highest indicated thermal efficiency claimed under test conditions with a Diesel engine (Mathot) 300 b.hp., four-stroke at three-quarter load, is 47 per cent. (36 per cent. brake efficiency). If 4 per cent. is allowed for radiation, 49 per cent. of the total heat is available for recovery, and if 10 per cent. efficiency is assumed for the steam cycle, the brake thermal efficiency of an engine giving this high result would be raised by 10 per cent. of 49 = 4.9;

that is, 36 + 4.9 = 41 per cent.; but there is no reason why the steam generated and used under the conditions of the Still system should be limited to so low a figure. Fifteen per cent., according to the author, seems a more reasonable assumption, and even a higher figure may be anticipated, in which case a brake thermal efficiency of 44 per cent. should be possible in a complete installation.

The exhaust gases take a subsidiary but important part in the cycle; their usefulness in ordinary combustion engines, in raising steam, is limited to the amount of heat recoverable between the initial temperature of the exhaust and that of, say, 50° F. above the steam temperature, after which the whole volume passes away to atmosphere at a still useful temperature, less a small percentage available for feed-water heating. But in the Still engine, the exhaust gases, after raising their quantum of steam, are employed in preheating all the water required for the steam generated in the jacket water and in the generator. Trials at full efficiency over long periods and steady loads, show terminal stack temperatures as low as 150° F.

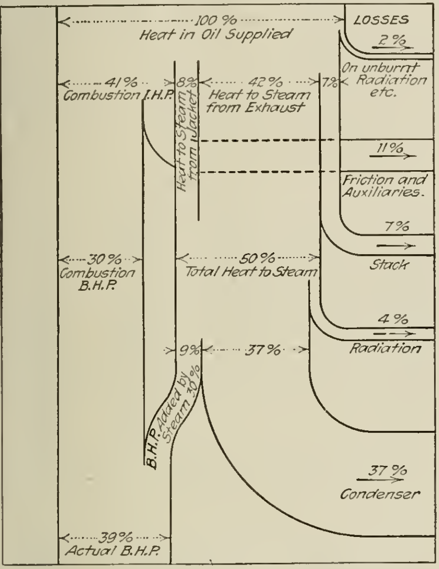


FIG. 2. CHART SHOWING DISTRIBUTION OF HEAT UNITS

The piston and cylinder walls, preheated by the combustion stroke, are at a higher temperature than the steam when it is admitted and while it is being expanded; there is, therefore, no loss from condensation, and the steam exhausts at a slight superheat above the normal expansion temperature, a condition which is unattainable in any form of steam engine without direct loss of energy. With an early cut off, it can be expanded economically right out to atmospheric pressure, or below it, and be either recompressed (Stumpf cycle) or exhausted to the condenser. The steam, during expansion, forms an efficient means of cooling the piston.

The Still oil engine starts with the cylinders and pistons preheated. The air charge, from the moment of its entry into the cylinder, picks up heat from the containing walls and continues to do so during at least 70 per cent. of the compression stroke, with the result that the temperature necessary for firing with certainty the first injected charge of fuel is reached with a compression pressure 50 per cent. less than that required in a Diesel engine.

This fact is far reaching in its importance, for it gives to the designer great elasticity and freedom of application; for a Still heavy-oil engine can be designed for constant pressure or constant volume, or both can be employed in the same engine by correct timing of the fuel injection. It claims for its combustion cycle an efficiency higher than that of the Diesel, less weight and space per horsepower, and for its combined cycle an efficiency not less than 20 per cent. higher than any prime mover which uses fuel as its source of heat.

Normal Load—The average m.e.p. from the combustion stroke was 90 lb. per sq.in. The steam evaporated by the "waste heat" gave 14 lb. per sq.in. m.e.p. on every return stroke. This is equivalent to 90 + 28 = 118 lb. per sq.in. m.e.p. in a normal four-stroke engine.

Overload—By admitting additional steam generated by fuel under the boiler, the steam m.e.p. was raised to 72 lb. per sq.in.; the total m.e.p. was, therefore, equal to 90 + 144 = 234 lb. per sq.in. m.e.p. in a normal four-stroke engine.

Business Training Recommended for Engineers

At the call of the Commissioner of Education, a two-day conference was held in Washington, June 23-24, and was attended by over 150 educators, representatives of engineering firms and prominent engineers. The concensus of opinion was expressed in resolutions passed at the final session favoring the addition to engineering curricula of courses in general economics, cost accounting and business law and urging that the economic phases of engineering subjects be emphasized in commercial instruction, and that the institutions that have departments of engineering and economics or commerce be urged to consider some plan of coördination to develop a course to prepare candidates to meet the demand for large numbers of technically trained men for both foreign and domestic commerce.

At the first session, Dean Anson Marston, of Iowa State College, led the discussion on business training for the engineer. Spencer Miller, vice president of the American Society of Mechanical Engineers and of the Lidgerwood Manufacturing Co., New York, placed first the need for developing character and outlined the qualities needed in engineering salesmen and the golden opportunities awaiting them. In the discussion was pointed out the danger of attracting too many men from the fields of design and research work, and the fact that it would be a mistake for all colleges to begin to train business engineers. Prof. G. H. Follows, of the department of commercial engineering at Carnegie Institute of Technology, Pittsburgh, outlined the course by chart and declared that a complete commercial training filled a four-year course, it being almost impossible for men who had taken ordinary engineering courses to become managers of men. It was stated that the reorganization plans at Harvard and Yale universities contemplate such specialization in the fifth year as graduate work.

ENGINEERING TRAINING FOR COMMERCIAL ENTERPRISES

Prof. Walter Rautenstrauch, of Columbia University, in discussing engineering training for commercial enterprises, insisted that no worthwhile instruction could be given without highly paid teachers. A department of manufacturing is contemplated at Columbia as a six-year course. E. F. Dubrul, president of the Pyro Clay Products Co., Cincinnati, claimed that the science of business was as broad and its ethics as high as any profession, and that executives are highly paid because they control both the engineering production and the commercial or distribution phases of industry. Money will be provided by business men if the educator will show willingness to adopt new methods for supplying the kind of graduate they need—the course to be devised in conference. He called attention to the new college of engineering and commerce at the University of Cincinnati as offering a coöperative course of large promise. In the discussion a Colorado executive was cited as authority for warning against too many business engineers, claiming fifty technical men were needed to one executive.

The third session was devoted to the significance of the war experience for engineering education, a paper by Maj. Gen. John F. O'Ryan, of New York, being read by Mr.

Swiggett. He pointed out the shortcomings of the present educational system in character training and suggested as a remedy the inclusion of nonsectarian moral law developed and applied by courses of psychology, leadership, responsibility and physical training. He urged a scientific program for developing professional character.

Dr. Charles R. Mann, chairman of the Advisory Board, Committee on Education and Special Training of the War Department, pointed out that both army men and practicing engineers place character first. He raised the question as to just what is meant by the "fundamentals" which so many advocate, and claimed that these fundamentals are at once apparent if the army method of beginning with a definite job asking what the engineer has to do, is followed. Thus the motive is developed, and results follow because the student is doing something definite and learns to think on the job. Morale is a dominant factor, better than character as a test, and he would judge classwork by group morale. The teacher should be a friendly investigator trying to lead the student to his best attainments rather than one who merely tries to meet certain set standards—and generally failing in a large proportion. The classification and rating system of the army should be applied—helping to measure accomplishments. The chairman, Maj. Gen. W. M. Black, Chief of Engineers, U. S. Army, advocated less individualism and the development of more coördination; also training for self-mastering through the subordination of passion to duty. He deplored over-specialization and suggested that engineering degrees should be withheld until after practice in actual engineering work had really qualified the graduate as an engineer.

Training for Overseas Engineers

At the last session, on Training for Overseas Engineering Projects, A. W. McLean, director of the War Finance Corporation, Washington, as chairman, emphasized the need for financing foreign investments, and for this country to assume to lead in foreign fields, claiming that engineers and business men can take the position of leadership if they have the courage and enterprise. C. H. Gardner, of the American International Corporation, New York, advocated more training in vision to see opportunities, especially in transportation, saying that the engineer should be the pioneer. He would have French and Latin required for college entrance. W. W. Nichols, chairman of the American Manufacturers' Export Association's Committee on Education, pointed out that industry and engineering are mutually dependent, that pure engineering belongs only to rare genius, and that the rank and file of engineers need a practical training. Foreign languages should be taught to develop knowledge of customs and mental attitude of the foreign peoples.

Dr. Jeremiah W. Jenks, research professor, government and public administration, New York University, in an illuminating address, showed two kinds of problems—to get trained men at once for overseas service and to develop such men for holding future supremacy in foreign trade. He classed commerce as one of the humanities, on a par with history and economics. Credit should be furnished in foreign fields, but only by controlling stock interests in order to insure wise and successful management. The discussion by men in industrial concerns interested in foreign fields, developed the necessity for long-time credits and for using ingenuity to find men with language qualifications and also sufficient technical knowledge to represent them abroad.

The Present Condition of Research in the United States *

Research work, quite general before the present war, became more extensive in overcoming the dastardly appliances of the Hun in devising new apparatus, products and manufacturing methods and in improving quality and production. The war has demonstrated, if demonstration is necessary, the value of research, and it is now the opinion of most of us that this stimulating viewpoint should not be lost and that wartime interest should be continued. For this reason it is well to consider the present condition of research in this country.

The cost of research in the past has been such that in many cases it could be undertaken only in an extensive way by large corporations. The necessity and value have been evident, but the small plant has been unable to inaugurate that which is known to be of value. However, the necessity for such work has been clearly seen and appreciated by some, and in this country institutions and foundations such as the Rockefeller Institute, the Carnegie Institution and the Sage Foundation are carrying on investigations and giving grants to those who are working on problems for the general good. Investigations have also been undertaken by an industry as a whole or by a group of manufacturers, and the results have been distributed among the contributors to the expense funds or, in some cases, freely given to the world. Various states have for over thirty years been conducting agricultural experiment stations for the benefit of the farmer. This field of research is rapidly widening. Engineering-experiment stations for the benefit of the farmer. This benefit of the manufacturers.

The equipment of technical schools is usually quite diversified and well adapted to research work. The lack of time for exhaustive experimentation, however, in schools of this kind is due largely to heavy schedules of instruction work. Nevertheless, some work of great value has been produced in technical schools by faculty members, graduate students and even by undergraduates.

Many engineering problems have been solved by the aid of university experiment stations, of which there are at present some fifteen in different colleges in this country; for instance, a coöperative plan of equipping a full size rolling mill at Carnegie Institute of Technology with special apparatus for research work definitely associated with the steel industry.

The government activities in research have greatly expanded since war was declared. At the Bureau of Standards research work in physics, chemistry, metallurgy, manufacturing and engineering has been done. There is hardly a branch of human endeavor that is not touched by this enormous research laboratory. Other government research work is carried on at the United States Naval Experiment station at Annapolis, the Forest Products Laboratory at Madison, Wis., the Watertown Arsenal, and the Philadelphia Navy Yard.

One of the great needs of the present time is that for more research men. Research demands a man of clear vision, great imagination, tremendous resources, absolute honesty, good training and devotion to work. The love of the work will have to be the incentive in many cases, as the monetary returns are small. The field of research is broader than ever, and if our colleges of engineering and science could by some means instill into more men the great desire for discovery through research, they would aid much in the contribution of this age to the welfare of the future.

Annex to Cleveland Municipal Plant

According to the Cleveland *Plain Dealer*, the $2,000,000 addition to the Cleveland, Ohio, municipal electric-light plant will be in operation early in July.

At the start the plant will have sufficient power to furnish energy to 14,000 consumers at prices ranging from 3c. a kilowatt in residences to 1¼c. in factories.

Additional generators will be installed later, and six times as many patrons will be supplied then. The new plant means cheaper current to thousands, as private companies charge from 10c. a kilowatt in residences to 1¼c. to large industrial consumers.

When all generators are in operation in the new plant the generating capacity of the combined establishments will be 76,000 kw. and it will be one of the largest public light plants in the world, according to Mr. Beckwith, superintendent of heat and light.

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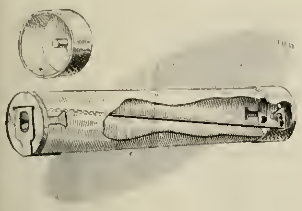
*From report presented at the Spring Meeting of The American Society of Mechanical Engineers, Detroit, Mich., June 16-19, 1919.

Condensed-Clipping Index of Equipment

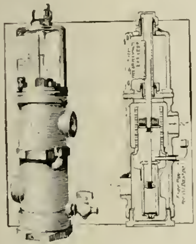
Clip, paste on 3 x 5-in. eards and file as desired

Fuse, Refillable
Volk Distributors, New York City
"Power," Apr. 22, 1919



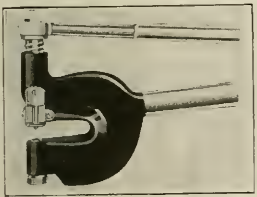
This refillable fuse is made up of a fiber shell closed at each end by metal disks and held by two dovetails that pass through the shell. The fuse element is in strips of standard form and passed through slots in the metal disk at each end of the shell. After placing the fuse element through the shell, the ends are bent over and the ferrules screwed on, making a contact between the ferrules and the fuse element. The fuse has but two removable parts and is made up to 60-ampere capacity. In sizes above 60-ampere capacity knife terminals are used.

Tool-om-eter, New Jersey Air
New Jersey Meter Co., Plainfield, N. J.
"Power," May 6, 1919



This meter shows direct on a scale, in cubic feet of free air a minute, the flow of air in pipes, etc. It operates with a small head or difference of pressure, established between the interior of the cylinder and the outlet chamber, the pressure difference being fixed by the exact weight of the moving elements and the area of the piston on which the difference of pressure acts. The meter has but one moving part, which is practically frictionless and nonwearing.

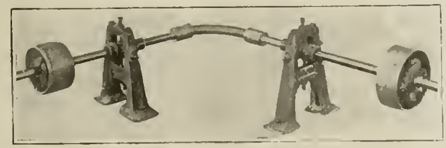
Punch, New Jiffy
Paul W. Koch & Co., 19 South Wells St., Chicago, Ill.
"Power,"



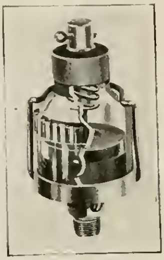
A compact portable punch weighing 5 lb. and 9½ in. long for tool kit or shop. Will punch $\frac{5}{32}$-, $\frac{3}{16}$-, $\frac{7}{32}$- and ¼-in. holes in metal up to No. 10 gage. Has disappearing stripper, giving clear view of punch and punch mark for next operation. Several sheets may be punched in one operation. Although designed for hand use, the punch may be clamped in a vise.

Coupling, "Karge" Cushion and Flexible
Three Rivers Machine Tool and Die Corporation, Phoenix, N. Y.
"Power," Apr. 22, 1919

This coupling is designed to take the place of flexible joints, gears, pulleys, belts and other mechanical devices used for the transmission of power. The coupling resembles a helical spring, and the coupling member is shrunk in the sleeve at each end. When applied to a shafting it can be bent and placed at almost any angle and will absorb shock and strain. Allowance is provided for the contraction and expansion of the spring lengthwise. The coupling is made of cast iron and the compression sleeves of steel. It is made in various sizes for shafting from ½ to 6 in. in diameter.

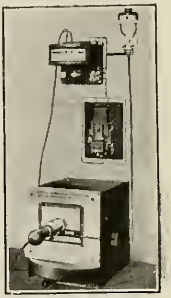


Cup, New Standard Grease
New Standard Manufacturing Co., 1325 Arch St., Philadelphia, Penn.
"Power," May 13, 1919



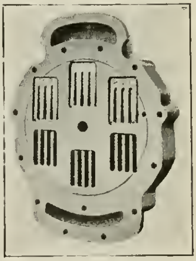
The body of this grease cup is made of brass and glass, the glass container being held in place by a double lock bail. A plunger under spring tension forces the grease out of the shank of the cup, the feeds being regulated by the tension of the spring and by the regulation of a screw in the shank. Three tensions of the spring are obtainable. A signal arrangement shows when the cup is feeding. It is refilled by unclamping the double lock bail. The capacity of the cup is 3 ounces.

Pyrometer, Brown Boiler-Room Signaling
Brown Instrument Co., Philadelphia, Penn.
"Power," Apr. 29, 1919



This device is designed to indicate the boiler operations when the temperature is too high or too low. Three lights are provided for each furnace—a green light indicating that the temperature is too low; white, that the proper temperature is being maintained; and red, that the temperature is too high. A contact table, adjustable throughout the whole scale range, carries three contacts corresponding to the three lights, the central contact operating the white light and covering a space usually of 20 deg. on the scale, amounting to 10 deg. plus or minus the desired temperature. The pointer of the pyrometer is automatically depressed once a minute on tungsten contacts.

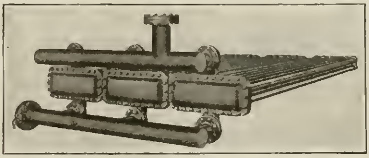
Plate Valves for Sullivan Straight-Line Compressors
Sullivan Machinery Co., Chicago, Ill.
"Power," Apr. 1, 1919



Improved compressor valves designed to secure rapidity of action, wide port openings with minimum wiredrawing effect and a reduction in the power required to operate them. The finger valve is of the grid form, shaped like a group of thin flat fingers or blades and made of sheet spring steel. It is bolted at one end only to a steel guard plate, the other end being free. The guard plate is curved to form a rest for the length of each blade, when it is bent or lifted by the incoming or outgoing air.

Superheater, Dravo
Superheater and Engineering Co., 233 Broadway, New York City.
"Power," May 13, 1919

This superheater is designed for use with various types of water-tube boilers and with return-tubular boilers. Steam is agitated as it passes through the apparatus and is thus brought into direct contact with the hot surface of the tube, tending to produce a uniform degree of superheat. The superheater conforms to the code covering the apparatus, as adopted by the American Society of Mechanical Engineers. The headers are of cast steel; tubes, seamless drawn steel. The superheater can be built in sections.



"The Engineer in Public Affairs" Discussed in Chicago

In various engineering societies there has been a great deal of talk recently about engineers taking a more active part in public affairs and particularly in matters of engineering interest. With the Western Society of Engineers the movement has developed to such an extent that there is now a committee on public affairs, and this committee has arranged joint meetings with the City Club, of Chicago, for the discussion of various civic problems of pressing need. The engineer is given an excellent opportunity to become informed and to give out reliable information on the engineering phases of the question. It is then up to him to discharge his duties as a loyal citizen.

The second meeting of the kind followed a 12 o'clock luncheon at the club on Tuesday, June 24. The topic was "How Can the Smoke Nuisance be Eliminated in Chicago?" Joseph Harrington, formerly administrative engineer for Illinois, of the United States Fuel Administration, was the first speaker. He divided the problem into three parts—legal, social and engineering. The legal situation was good, it being a question more of the enforcement of the present ordinance rather than the need for passage of new laws.

Regarding the social phase, relating to health, general cleanliness, injury to property, etc., conditions were almost as bad as they had been before any attempt had been made to abate the smoke nuisance. It was a pity that conditions had been allowed to get into such a state, and it was essential that something should be done.

As to the engineering division of the subject, engineers were generally agreed that smokeless combustion of Illinois coal could be accomplished. A smoky plant was a reflection on the engineer who designed it or on the engineer who was operating the plant. Cleaning up Chicago would effect a practical economy. The engineers knew what was wrong and in the engineering sense what remedy to apply. The whole question was more a civic problem of public sentiment than engineering.

What Is Needed to Clean Up Chicago

Some of the requirements were a chief smoke inspector who is a combustion engineer, a good executive who can meet representative men of the city and a man who can go into the boiler room and discuss combustion problems with the engineer. For such a man the present salary was too low. It should be increased to a figure commensurate with the qualifications required.

At one time there had been a smoke commission composed of business men of high standing, which got things done that could not have been accomplished in any other way. Mr. Harrington was of the opinion that this commission should be revived. It should be composed of representative business men and should include an attorney, two engineers of high standing to give advice on engineering matters and representatives of the press and of financial interests. The press was required, as the success of the present movement ultimately hinged on the ability to create a demand for the things under discussion. Showing up offenders in the press and giving credit to those doing good work would also have an important bearing on compliance with the smoke ordinance.

Where it was necessary to remodel a plant in order to effect smokeless conditions, there were frequent cases in which owners could not afford to make the changes. If the engineers on the commission found that certain changes were necessary, and the attorney made sure that the credit of the owner was good, it would be a business proposition for the banks to advance sufficient funds to pay for the work. The saving would eventually pay for the new equipment. All that was needed was time and it was a question of allowing the banks to "hold the bag."

Education was really the groundwork of the whole movement. Upon proper publicity will depend the growth of public sentiment, which is the motive power in this case. There were two or three live engineering societies in the city that would be glad to coöperate to the utmost in any effort made by the City Club.

Summarizing, the speaker said there was need for a high-grade smoke department and a high-grade chief inspector, backed up by a representative commission, the movement to be supported by the City Club and other associations capable of waging a strong campaign of education.

Harold Almert, who also had been with the Fuel Administration, talked on the domestic side of the question. Of the millions of tons of soft coal shipped into the Chicago switching district, 85 per cent. was burned in industrial plants and 15 per cent. by domestic users. It was this 15 per cent. that caused most of the trouble, as it was responsible for 70 per cent. of the smoke. The speaker outlined briefly how conditions in domestic heating plants could be improved. The kitchen range was the worst offender and next in order was the hot-water heater owing to the low temperatures in the flame passages and the continuous operation 24 hours per day every day in the year. The heater can be fired smokelessly by leaving the door open ten to fifteen minutes to provide enough air to burn the volatile while the coal is coking. Most of the trouble is due to visiting janitors who rush in and out and make no effort to secure smokeless combustion. Of the larger installations, 95 per cent. were designed for soft coal. There was an abundance of fuel in Illinois suitable for domestic use and there was no occasion to use coal from the East. By using the coking or alternate method of firing, there would be no trouble from smoke.

Creation of a desire for civic cleanliness should be the first step in the program. It would mean a saving to the city of $75,000,000 per year, due to less painting and cleaning of buildings, clothes and other factors aggravated by smoky condition existing at present. Outside of this there was the question of the betterment of health.

Frank A. Chambers, acting chief smoke inspector, who was to have addressed the meeting, was unable to attend. No specific action was taken at the meeting, but it was hoped that developments would come later.

Canadian Association of Stationary Engineers' Convention

The thirtieth annual convention of the Canadian Association of Stationary Engineers was held at Brantford, Ont., June 23 to 26 inclusive, with headquarters at the Kerby House.

The main hall of the Tabernacle, situated within walking distance of the headquarters, was tastefully decorated and conveniently arranged for the use of the Canadian Exhibitors' Association in the display of power-plant equipment and accessories. Forty-six firms in the engineering supply field occupied booths. The exhibit was liberally patronized during the four days.

The several sessions of the delegates were held in a hall adjoining the exhibit. Many of the engineers were prevented attending this year because of railroad strikes in a number of the Canadian cities. A large number of subjects of significant value to the organization were brought forward, discussed and acted upon. The engineers of the Dominion of Canada are graded into first, second and third classes, with interchangeable certificates, according to ability. All the local lodges will make an urgent educational campaign the coming season, with the object of promoting those engineers holding other than first-class certificates.

The opening ceremonies took place on Tuesday morning, with Charles Walker, president of the Brantford lodge, occupying the chair. D. L. Webster, chairman of the Convention Committee, welcomed the delegates and guests to Brantford. William Cook, of Belleville, president of the Canadian Association of Stationary Engineers, responded. C. N. Schrag, of Toronto, president of the Canadian Exhibitors' Association, spoke of the pleasure it gave the members of his association to be with the engineers, and hoped that the delegates would be pleased with the display. Lieut. Lloyd Archibald, past president of the Exhibitors' Association, gave a short talk on his experiences as a German prisoner. Fred W. Raven, of Chicago, secretary of the N. A. S. E., spoke at length on the benefit of the social and educational features of the organization. C. Z. Wyse, G. C. Keith and George Moll also made interesting addresses, and Bob Jones, of the France Packing Co., sang tenor solos.

On Monday evening a lecture on "Heating by Steam" was given by E. T. Flanagan, of the C. A. Dunham Co., of Toronto, which was followed by a paper on "Refrigeration" by I. J. Tait, of Montreal.

On Tuesday afternoon visits were made to some of the Brantford factories.

On Tuesday evening a smoker was held in the Tabernacle. C. J. Porter, of Hamilton, gave an interesting illustrated lecture on generators. Fred W. Raven read a paper on good fellowship. H. D. Maclochlan, of the Department of Technical Education of Ontario, invited the members of the C. A. S. E. to take part in the evening educational schools of the government. He said there were 41 of these schools, and he hoped the engineers would take advantage of the offer. At the close of Mr. Maclochlan's address the engineers decided to coöperate with the government in its efforts, and requested the speaker to convey the thanks of the organization to the department. D. M. Medcalf, chief boiler inspector for Ontario, gave an address on the causes of boiler failure, and showed parts of several boilers that had failed. Jack Armour, of *Power*, entertained. Good things to smoke were furnished.

THE EXHIBITORS ENTERTAIN THE CONVENTION ON WEDNESDAY AFTERNOON

On Wednesday afternoon the exhibitors entertained the convention at the armory. This event was to have been a picnic at Mohawk Park, but the inclement weather forced the picknickers into the spacious armory. Sports of all kinds for men, women and children were indulged in, including hockey and baseball with prizes for the first and second in each event. Refreshments were abundantly served, and notwithstanding the rainy day a pleasant afternoon was spent.

On Wednesday evening the biggest attendance of the convention took seats in the Tabernacle to listen to the entertainment. After the distribution of prizes to the winners in the afternoon events, an enjoyable program was furnished by the following: E. B. Curzon, baritone solo; Miss Emily Powell, soprano solo; Miss Emma Jackson, reading; C. B. Turner conducted a sale of curios for the benefit of the Brantford General Hospital; E. F. Hetherington, ballads; Bob Jones, tenor solos, and Jack Armour in stories and recitals. The performance closed with a prize drawing contest after which an illustrated lecture on turbines was given by J. M. Brown, of Hamilton.

On Thursday evening there was a reception and ball at the Masonic Temple, which proved a success in every way. The grand march was led by C. B. Turner.

At the final meeting of the delegates the following grand officers were elected and installed: William Cook, Belleville, past president; George Moll, London, president; I. J. Tait, Montreal, first vice president; Daniel L. Webster, Brantford, second vice president; Frederick Harper, Kingston, third vice president; John Hale, Hamilton, secretary-treasurer; R. C. Leach, Toronto, conductor; George Lee, Ottawa, doorkeeper. Delegates to the N. A. S. E. convention at Huntington, W. Va., William Cook.

At the meeting of the exhibtors on Thursday morning the following officers were elected: James Mock, Montreal, president; J. J. Fitzgerald, Montreal, first vice president; Grant Cole, Toronto, second vice president; Lloyd Archibald, Toronto, treasurer; George N. Wilkinson, Philadelphia, assistant secretary; Arthur Betton, Edward Hanson, Howard Fletcher, exhibit committee; W. R. Sexton, Harrold Burbridge, H. W. Cockfield, reception committee; Edward B. Curzon, J. Thompson, Earl Gordon, entertainment committee.

It was decided to hold the next convention at Woodstock, Ont., in June, 1920.

Engineering Council Notes

Contributed by M. O. LEIGHTON, Chairman
National Service Committee

Far-reaching changes in the executive machinery of the Federal Government were proposed recently in bills introduced in each house of Congress. The Department of the Interior will become the Department of Public Works if the legislation proposed is enacted. The main idea is to assemble all engineering activities of the Government in one department.

Such bureaus of the Interior Department as are non-engineering in character are to be placed under the jurisdiction of appropriate departments, while engineering bureaus from other departments are to be included in the Department of Public Works. The bill proposes that the Patent Office is to be removed from the Interior Department and placed under the Department of Commerce. The Bureau of Pensions is assigned to the Department of the Treasury. The Bureau of Education goes to the Labor Department. The Bureau of Indian Affairs also is transferred to the Department of Labor, with the proviso that the engineering and construction work and the land and mineral surveys now performed under the direction of the Bureau of Indian Affairs are to be prosecuted under the Department of Public Works. St. Elizabeth's Hospital and the Freedman's Hospital in this city are assigned to the Treasury Department. Columbia Institution for the Deaf and the Howard University go to the Bureau of Education, under the provisions of the bill.

On the other hand, the Department of Public Works is slated to absorb the Supervising Architect's Office of the Treasury Department; the Construction Division, River and Harbor Improvements, Mississippi River Commission, and California Débris Commission of the War Department; the Bureau of Standards and the Coast and Geodetic Survey of the Department of Commerce; the Bureau of Public Roads and also the Forest Service of the Department of Agriculture.

The bill provides that the Secretary of Public Works "shall by training and experience be qualified to administer the affairs of the department and to evaluate the technical principles and operations involved in the work thereof." The measure excepts from the foregoing provision the Cabinet officer who is at the head of the department at the time of the passage of the bill.

Four assistant secretaries, each to be paid $7500 per annum, are provided and their duties outlined. One is to have administrative jurisdiction over all matters of engineering design and construction. Another is to have charge of architectural design and construction. The third is to have jurisdiction over all scientific work and surveys, while the fourth is to be in immediate charge of all land and legal matters. The assistant secretaries are charged with the duty of coördinating and bringing into efficient relationship all the activities of the department so that it may be harmoniously and efficiently administered.

An important feature of the bill is the proviso that engineer officers of the United States Army detailed on non-military work are to be assigned by the Secretary of War to like duties under the new department for not over two years. This enables the Secretary of Public Works to make gradual transfer of improvements and instrumentalities to civil administration without detriment to public interest. Members of the Corps of Engineers may, under the direction of the Secretary of Public Works, be detailed by the Secretary of War to temporary duty in the new department for such instruction, training and experience as is desired.

Four hundred and eighty-five locomotives sent abroad for the use of the American army have been sold to the French government. Two hundred and twelve engines and 12,404 cars remain to be sold.

Admiral Griffin Receives Honorary Degree

The honorary degree of Doctor of Engineering was conferred upon Rear Admiral Robert S. Griffin, engineer-in-chief of the United States Navy, by the Stevens Institute of Technology of Hoboken, N. J., on June 17. While comparatively few, outside of those intimately connected with naval engineering affairs, are aware of the vast scope of his activities, and especially the responsibilities carried during the period of the war, it will be a source of gratification to his friends and associates to learn of this richly deserved honor.

The new navy may be considered as commencing with the Roach cruiser about 1885, at which time Admiral Griffin was an inspector of machinery for those vessels. From that time down to the present, except for tours of sea duty, he has had an active and responsible part in the equipment efficiency of our naval vessels.

ADMIRAL ROBERT S GRIFFIN

Admiral Griffin, for more than five years, was the assistant of the late Admiral George W. Melville, engineer-in-chief of the navy, and in 1913 was appointed chief of the bureau. The efficiency of his administration has been so great that when the four-year detail had expired in 1917 the Secretary of the Navy, contrary to precedent, continued him as chief of the bureau.

Upon his professional skill and the efficiency of his department depended the readiness of the fleet, and the rapid and safe transportation of our armies to France. Our vessels and personnel were ready mainly because Admiral Griffin and his staff had anticipated the emergency and had plans completed to meet it.

Some idea of the magnitude of this work can be obtained by considering that the navy had under its care the machinery of nearly 2000 vessels, of which 570 were of our regular navy. The aggregate horsepower of these ships is about six and one-half million. If we add to this the total of the number of vessels under construction, more than 400 could be added and the aggregate horsepower increased to eleven million.

The work of the Bureau of Steam Engineering covers the motive power of all naval vessels, and includes also the electrical machinery, the radio telegraph and machinery for naval air craft. The first installation of electric drive in the navy, that on the battleship "New Mexico," and the rehabilitation of the damaged machinery of the interned German ships, came within the scope of the bureau.

Admiral Griffin is a man of culture, a writer of excellence upon engineering subjects, and is extremely modest by nature. He has never been one to advertise his work.

He was born in Richmond, Va., in 1857, and graduated from Annapolis in the class of 1878.

Fiftieth Anniversary of Western Society of Engineers

On June 27 and 28 the Western Society of Engineers celebrated its fiftieth anniversary. The society was organized May 25, 1869. It was known as the Civil Engineers' Club of the Northwest until 1880, when it was reorganized and its present name adopted. In the society rooms in the Monadnock Building, Chicago, a meeting was held at 3 o'clock at which a résumé of the society's history was given by Secretary Nethercut, who mentioned specifically the founders, Messrs. Mason and Paine, and reviewed briefly the work of all charter members. Following there was a brief review of the development of the society, including statistics on membership, which, roughly, up to 1909 had doubled every ten years. For the last ten years it has remained practically stationary in the vicinity of 1100, the lack of growth being due principally to the activity of national societies forming local chapters in the city. Some of the notable achievements of the society were mentioned briefly and some of the recent changes in its work to meet the progressive attitude of the day were enumerated.

In conclusion the secretary could see no good reason for 13 chapters of national societies and several distinct local engineering societies in the city. There should be one technical society in Chicago common to all, the Western Society of Engineers acting as a center. It was estimated that an all-embracing society of this character could have at least 5000 members, with an engineering building in prospect to serve all branches, of engineering. There was no intention to limit the local membership of the national societies, for such an organization as outlined would stimulate their growth.

Engineering development of the past half century was a topic that had been divided into several subdivisions and assigned to a number of speakers. S. O. Dunn, editor of *Railway Age*, reviewed the developments in railway engineering. J. R. Bibbins spoke on the great advance in steam engineering. Electric light and power was covered by James R. Cravath. Electrical communication, including the telephone and the telegraph, was covered by F. F. Fowle, and John W. Alvord in a few concise statements gave the high lights in sanitary engineering during the period under discussion.

On Friday evening there was a reunion smoker, including motion pictures, messages from past presidents, instrumental music, songs by the Universal Quartet, community singing, refreshments and an address by Col. Henry A. Allen on the work of the 108th Engineers. The colonel reviewed the training period, the trip across to France and the military experience of the regiment in the war zone. Particular reference was made to the colors that had been presented to the regiment by the Western Society of Engineers.

In the history of the society there have been 39 presidents, of whom 33 were living and 12 were present. Of the latter each addressed the meeting briefly, bringing up reminiscenses of the past. Others who could not attend had forwarded messages for presentation.

Saturday, June 28, was given over to a family-reunion basket picnic at The Dunes, for which an excellent program had been prepared. There were games, races and bathing. The picnic proved to be a most enjoyable occasion.

Labor Situation in New York State

Some interesting facts concerning the factory employment situation are made public in a bulletin issued by the Bureau of Statistics and Information of the New York State Industrial Commission. An abstract of the bulletin follows:

After declining steadily since last November, the number of employees in the factories of New York State remained practically stationary from March to April. This seems to indicate that the readjustment from a war-time basis to the regular business of peace-time has been largely accomplished. The number of workers is now 8 per cent. lower than in November, but is still 11 per cent. higher than the pre-war level, and no prospect of much further reduction appears probable at this time.

The total of wages paid by the factories of the state was about 1 per cent. lower in April than in March. The total of payrolls is 11 per cent. lower than in December, 1918, but 95 per cent. higher than in June, 1914.

Some reduction in hours are still being reported, but no reduction in wages.

The cost of food is now 84 per cent. above the level of June, 1914, and the average earnings of factory workers have increased 74 per cent. For industry groups this increase in average earnings ranges from 53 per cent. for the printing and paper group to 87 per cent. for stone, clay and glass and for paper manufacture.

The employment situation in the state in April shows that for every 100 workers called for, 80 registered as seeking employment, against 89 in March and 96 in February. Only in building work and clerical occupations were there more applicants than jobs. All branches of manufacturing show more positions open than applicants.

Water-Power Bill Before Congress

Representative Esch, of Wisconsin, chairman of the Joint Water Power Committee of the House of Representatives, began the first debate in the present extra session of Congress on the subject of water-power legislation, in the House, June 27, when he presented for the consideration of the House the bill adopted by the committee (H.R. 3184) to create a Federal power commission and to define its powers, duties, etc.

The debate continued for two hours, although no action was taken upon the bill. Representative Sims, of Tennessee, former chairman of the Joint Water Power Committee in the previous Congress, was in charge of the presentation of the views of the Democratic minority in the House, although he announced that he was in favor of the bill and concurred in the statements Representative Esch made in presenting the bill.

The presentation by Mr. Esch of the arguments in favor of the passage of the legislation marked the first appearance in charge on the floor of the House of Mr. Esch. He said:

> If we had had this legislation six or eight years ago, we would have been in an entirely different situation when we entered the war. One of the great needs of the war, one of the great shortages of the war, was the matter of power; had the situation been such as might have been possible under the bills which have heretofore been passed in this House, we would not have suffered from that shortage as we did, and we would have had greater production. I hope the time is near at hand when the repeated efforts from the House of Representatives to secure adequate water power legislation may bear fruit.

During the general debate that followed, Representative Stevenson announced that he intends to offer an amendment altering the method provided in the bill for the condemnation of property. This brought about a general discussion by Representative Black, Representative Kinkaid and others as to the questions of eminent domain and rights of the state and the Federal governments under that principle.

Representative Ferris called the attention of the House to the fact that on Feb. 28 last, the House "after very full and careful consideration of the conference report passed this identical bill by a vote of 263 for to 65 against," showing, he said, that at that time, "after long consideration the sentiment of the House was overwhelmingly for the bill," and he assumed that it is now.

Representative Ferris said he was proud that the House is getting up the water-power legislation early in the session and that he hoped the Senate will take it up at once. "For example," he said, "the engineers who have examined the subject assert that we have in the United States potential water power ranging all the way from 35,000,000 to 200,000,000 hp. of hydro-electric energy. The fact remains that only 6,000,000 hp. of that entire amount is in use, and that the rest is running idly to the sea, doing no one any good." Mr. Ferris made a few suggestions as to possible alterations in the bill, after saying that there is apparently not to be much controversy about the bill in the House. He called attention to the necessity of avoiding any changes or modifications which are vital, and which, although slight in appearance, might be far reaching in effect.

The more optimistic friends of the proposed water-power legislation had hoped that the House would pass the bill unanimously and with practically no debate, but no vote was reached. Representative Esch proposes to press for the passage of the legislation.

The Decline and Ultimate Production of Oil Wells

A bulletin by Carl H. Beal has been issued by the Department of the Interior in which he states that the limit of production of petroleum in this country is being approached, and while new fields doubtless are yet to be discovered, the yearly output will inevitably decline. More wells will be driven and every effort to discover and develop new fields will be made, but while an increase may result for a time, such increase will become impossible after a certain point is reached.

At present the country is facing a serious shortage of petroleum. In order to meet this emergency the Bureau of Mines has been carrying on investigations for a number of years. However, the field covered by these tests has been limited to actual producing problems such as drilling, efficient recovery of oil, storage, etc. But these investigations have failed to touch upon the matter of ultimate production, that is, upon how much oil a well or group of wells will produce in the future, and at what rate.

Formerly, this question bothered the producer not at all. Undrilled acreage was plentiful, so little or no attention was directed to conservation and future production. Recently, the oil industry has been forced to cut down operation to a more conservative level. They are demanding a more complete knowledge of the probable future production of wells and oil lands. Probably, as fewer and fewer large oil fields are discovered, the oil industry will more and more seek the aid of science. The technical man will find his services needed in every branch of the industry, especially in the selection of probable new oil lands, and in determining the value of producing and prospective oil fields. When the information as to capacity and rate of production can be given with approximate exactness, the producer will be able to obtain a fairly trustworthy idea of his future yearly income, and the worth of his property, as well as that of other oil fields he may contemplate purchasing.

It is going to be the duty of the petroleum engineers to obtain these facts. But from where? At present suitable statistics upon which to base such deductions are mostly in the hands of competing companies. Undoubtedly, such material can best be collected, analyzed and published through the medium of the Federal Government.

But most petroleum engineers lack training in the principles of valuation. This is not surprising. This phase of the work is comparatively new, but none the less the question of valuation is going to be one for the petroleum engineer to answer. His familiarity with the origin and accumulation of oil and gas and their relation to geologic structure is of first importance for the scientific valuation of producing and prospective oil lands. It is up to the engineer. He should strive to meet the probable requirements of this specialized branch of petroleum technology.

Boiler Explosion at Des Moines

A portable boiler exploded June 14, in the plant of the Des Moines Asphalt Paving Co., Des Moines, Iowa, slightly injuring two workmen. The building over which the boiler was stationed, together with the engine, was totally wrecked. The damage, not including the boiler, is estimated at $500. The rupture occurred at the first girth seam, some of the rivets shearing, and the plate breaking clean in other places where the sheet had crystalized. The rupture extended about one-third of the circumference of the 36-in. shell. The thickness of the plate was seven-sixteenths inch. According to the man in charge the boiler had been in use fifteen or twenty years. It did not leave its setting.

At a recent meeting of the Diesel Engine Users Association of London, England, the subject of insurance against breakdown occupied the attention of the members. Some time ago the association adopted a standard form of insurance policy against breakdown of this type of machine, and one of the conditions of the policy is that in case of disagreement of the interpretation of the policy the matter shall be submitted for arbitration to a special committee of the Diesel Engine Users Association, whose decision is to be final and binding on both parties.

A large air chamber is often necessary on a pump or suction line when the line is long and the lift is high.

Personals

A. P. Little, formerly of the Bureau of Standards has been appointed professor of electrical engineering in the Colorado School of Mines.

George S. Cooper, formerly mechanical engineer with the Buckeye Engine Co., of Salem, Ohio, is now research engineer for Hooven, Owens, Rentschler Co., of Hamilton, Ohio.

G. D. Farnham, formerly with The Westinghouse Church Kerr Co, of New York City, has accepted a position with the McCann-Harrison Co., of Cleveland, Ohio, as chief engineer of its power and heating department.

Charles H. Garlick has been reappointed state steam boiler inspector for Allegheny County, Penn., by Gov. William C. Sproul. Mr. Garlick has held this position under three governors during the past seven and a half years.

L. W. W. Morrow has been made assistant professor of electrical engineering at Yale University. Professor Morrow was in charge of one of the divisions of the Signal Corps Training School for Officer Candidates.

Raymond G. Sherman has been promoted from the position of superintendent of the Deerfield River Power Co. to that of superintendent of the Connecticut River Power Co. Both companies are under the management of the New England Power Co.

J. C. Walton, consulting engineer, has been elected mayor of Oklahoma City, a town of 100,000 inhabitants. His efficient administration as Comissioner of Public Works resulted in his choice as mayor when his term as commissioner was but half completed.

Stanley J. Quinn, secretary of the American Manufacturers' Export Association, has resigned to accept a position with one of the members of the association. Robert F. Volentine who, for the last several months has been associated with the Brooklyn Chamber of Commerce, was elected as his successor.

H. M. Turner has been made assistant professor of electrical engineering in the Sheffield Scientific School. Profesor Turner has been connected with the department of electrical engineering of the University of Minnesota, and came to Yale last fall as an instructor in the Signal Corps Training School.

W. A. Moore, who has been connected with the piping department of the M. W. Kellogg Co. for a number of years, and during the war was chief inspector in the Ordnance Department, has assumed charge of the New York office of the M. J. Dougherty Co., power piping contractors, North American Building, Philadelphia, Penn.

Samuel F. Joor, a well-known consulting engineer, of Chicago, has joined the American Steam Conveyor Corp., Chicago, in the capacity of sales engineer. Mr. Joor has had wide experience in the conveyor field, at one time being Western manager and sales engineer of the Jeffrey Manufacturing Co., and previous to that with the Link Belt Co.

G. F. Wittig has been made assistant professor of electrical enginering in the Sheffield Scientific School of Yale. He had been connected with the Signal Corps Training School for Officer Candidates for the past year. Professor Wittig was formerly connected with Westinghouse Church Kerr & Co. Later he was professor of electrical engineering at the University of Pennsylvania. He is a graduate of Columbia.

George Ellery Hale, director of the Mount Wilson Observatory and foreign secretary of the National Academy of Sciences, who has been for the last ten years a correspondent of the Academic des Sciences, Institut de France, has received the unusual honor of election as Associe Etranger, taking the place of Adolph von Baeyer, declared vacant by the Academy. The foreign associates are limited to twelve, and the high distinction has been held by only two Americans—Simon Newcomb and Alexander Agassiz. The National Research Council upon the presentation and acceptance of Dr. Hale's resignation as its chairman and the election of James R. Angell as his successor, created and bestowed in perpetuity upon Dr. Hale the title of Honorary Chairman in recognition of his services to the National Research Council and to science and research by indefatigable efforts that have contributed so largely to the organization of science for the assistance of the Government during the war, and the augmentation of the resources of the United States through the newly intensive cultivation of research in the reconstruction and peace periods that follow.

Engineering Affairs

Michigan State Association N. A. S. E., will hold its annual convention at Grand Rapids, July 23-25.

Wisconsin State Association, N. A. S. E., will hold its annual meeting at Madison, July 30, 31, August 1.

Minnesota State Association, N. A. S. E. convention will be held this year at Minneapolis, August 6-8.

Universal Craftsmen Council of Engineers will hold its annual convention at Newark, N. J., August 5-8. The Robert Treat Hotel will be the headquarters, and in this building the sessions of the delegates and the mechanical exhibit of the supply men will take place.

Phoenix Association No. 24, N. A. S. E. held its annual outing and field day at the American Park, College Point, N. Y., on Sunday, June 29. The outdoor sports ended with a baseball game between the engineers and supply men, the former winning by the score of 12 to 6. Fully 250 enjoyed the dinner that followed

The American Association of Engineers has chartered during the past week clubs at Tulsa, Okla., Eureka, Col., Norfolk, Va., Fond du Lac, Wis., and Akron, O. The following are the officers at these clubs: Tulsa Club, C. C. Toomey, Carter Oil Co., Tulsa Okla., Pres. Eureka Club, F. W. Howard, Secy., Korbel, Cal., Fond du Lac Club, O. J. Husemeier, Pres., Box 85, Fond du Lack, Wis. Akron Club, R. B. Jackson, Secy., 395 Boyle St., Akron, Ohio.

Tidewater, Va., Valtey Chapter, A. A. E., has elected the following officers: President, W. P. Tunstall; secretary, R. W. Bonney; treasurer, G. H. Massey. The Tidewater chapter includes in its jurisdiction the following cities: Norfolk, Portsmouth, Suffolk, Newport News, Hampton, Phoebus, Fortress Monroe, Army Supply Base and Navy Supply Base, Va.

Miscellaneous News

The Electrical Exposition and Motor Show is to be resumed this year, opening at the Grand Central Palace, New York City on Sept. 24. This will be the first show since 1917, last year's display having been omitted on account of the war. The Grand Central Palace was used during the war as a debarkation hospital.

Railroad Engineers Salaries.—The matter of proper salary for engineers in railroad service which the American Association of Engineers presented to the Wage Board of the United States Railroad Administration is now under consideration, and, according to a letter received by the association secretary, will be brought to an early conclusion.

Prospects for Foreign Business—C .R. Messinger, vice-president of the Chain Belt Co., Milwaukee, who recently returned from a three months' investigation of business conditions in Europe, believes that the United States will get the big bulk of European trade after business conditions become more normal. At present European business is marking time and the general feeling seems to be that even the signing of the peace terms will not bring about any great change immediately. When things do open up, however, American manufacturers will be found in better shape than their European competitors and should get the bulk of the business, though liberal credit terms will be necessary. C. L. Pfeifer, treasurer of the same company, has just returned from a several weeks' stay in Cuba where he studied business conditions generally. In his opinion Cuban business is in a very prosperous condition, with indications that this will continue for perhaps three years. The country has just broken all records in its sugar crops, and planters feel that the succeeding crops will be still greater.

The Fifth National Exposition of Chemical Industries will be held in the Coliseum and First Regiment Armory, Chicago, during the week of Sept. 22, and will be a convocation of societies in connection with the exposition. The American Institute of Mining Engineers will occupy the stage for the first part of the week, later the American Ceramic Society, the American Electrochemical Society, and the Technical Association of Pulp and Paper Industry. Among the interesting features of the exposition program will be a symposium on "Safety in the Plant and Mine," with speakers of authority in this work under the chairmanship of M. L. Leopold, safety engineer of the United States Bureau of Mines, and in the evening there will be shown a series of motion pictures of safety work in plant, field and mine, made in industrial plants all over the country under the supervision of Government agents. Even in motion pictures as in all important improvements in plant machinery and products, the exposition is outstanding as the place of introduction to the public of the newest and most recent developments. Each improvement of the projectoscope in motion-picture projection has been reserved for first public demonstration at the exposition and again this year will have the latest developments in this field of endeavor.

Business Items

Mayer & Valentine, heating ventilating and power plant engineers, announce the opening of an office at 615 Bangor Building, Cleveland, Ohio.

The Hammel Oil Burning Equipment Co., Inc., of Providence, R. I., has opened a New York City office at 110 West 40th St., with James J. Tyrrell in charge.

The Roberts Co. has opened an office at 1049 Drexel Building, Philadelphia, as consulting and contracting mechanical engineers and general machine designers.

The Bound Brook Oil-Less Bearing Co., Bound Brook N. J., is having built a new machine shop and office building of concrete and steel construction on Lincoln Boulevard, adjoining the present foundry.

The Walter A. Zelnicker Supply Co. has added 2000 sq.ft. to its present office space at 325 Locust St., St. Louis, Mo. This improvement will enable this organization to continue to efficiently render Zelnicker service.

The Midwest Engine Co., of Indianapolis, Ind., announces the opening of four branch offices as follows: Jacksonville, Fla., with D. J. Carrison in charge, with offices in the Florida Life Building; El Paso, Tex., offices at 303 Caples Building, with Chester B. Loomis in charge; New Orleans,. La., offices at 617 Maison Blanche Building, with J. R. Lowe in charge; New York City, at 111 Broadway, with B. H. Downing in charge.

The Steam Motors Co., Springfield, Mass., announces that the following have been appointed as its representatives to cover their respective territories: K. N. Jackson, Monadnock Building, Chicago, Ill.; F. H. Mason, Moffat Building, Detroit, Mich., Morgan-Gerrish Co., 501 So. 6th St., Minneapolis, Minn.; R. T. Coe, Insurance Building, Rochester, N. Y.; Southern Engineering Co., 425 Gravier St., New Orleans, La.

The Harrison Safety Boiler Works, Philadelphia has acquired the Monash line of pressure-reducing valves and pump governors, formerly manufactured and sold by the Monash-Younker Co., of New York and Chicago. The purchase includes a stock of manufactured parts and valves, drawings, patterns, trade-mark, and good will. The Harrison Safety Boiler Works will manufacture and market the valves under the trade name "Cochrane-Monash," and will supply repair parts for valves now in use.

S. F. Bowser Co., Ltd., of Toronto, Ont., has been recently reorganized to operate as a strictly Canadian organization, financed and managed under Canadian control, and as a separate institution from the home office at Fort Wayne, Ind., under which it was formerly operated. H. C. Christie, who has been a number of years connected with the Canadian factory of the company as sales manager, has been elected manager, with E. E. Cummings as factory manager. The other officers are: S. F. Bowser, president; S. B. Bechtel, vice president; H. J. Grosvenor, secretary and W. G. Zahrt, treasurer. The policy of the firm under the new management will be along the same lines as heretofore.

Trade Catalogs

The Standard Spiral Pipe Works, Chicago, Ill., has issued a 40-page catalog (No. 7) fully describing and illustrating the company's reinforced spiral pipe. List prices of pipe of various sizes and standards are given, as well as of other pipe fittings, etc. A couple of pages of useful engineering information are included.

Lagonda Automatic Cutoff Valves. The Lagonda Manufacturing Co., Springfield, Ohio. Catalog S-2. Pages 32; 6¾ x 10 in. This catalog fully describes and illustrates the various types of Lagonda automatic valves, and shows diagrams of the valves installed in various vertical and horizontal positions. A copy may be had free upon request.

The Northern Equipment Co., Erie, Penn., has just published an eight-page bulletin, 8½ x 11 in., embodying specifications for the Copes system of boiler-feed regulation. This bulletin discusses the principle of operation, heat storage reduction of furnace temperature fluctuations, thermostat, standard dimensions and drilling, the Copes steam pump governor, etc.

The Bastian-Blessing Co., Chicago, has isued a bulletin entitled "A New Principle in Welding and Cutting Apparatus." Rego welding and cutting outfits were first placed on the market about a year ago and have made good to such an extent that they are now being used in nearly all large cities. Rego torches, which have eliminated the flashback, are also described in this bulletin. A copy may be had free upon request.

Lea-Courtenay Co., New York City, has issued a 27-page bulletin "C," entitled "Artificial Draft for Economy and Greater Boiler Capacity." It contains seventeen illustrations showing the application of this system, called the "Cotton System," to various types of boilers. Bulletin "S," by the same company, describes and shows various installations of the Cotton Jet stoker; and Bulletin No. 210 the Cotton blower, grate, ashdoor furnace and smokeless furnace.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7 80@7 95
Stove	7 95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2 15@2 75	$2 75@3 25
Philadelphia, gross tons	4 27@4 95	5 95@5.50
New York, gross tons	4 62@5.29	5.29@5.85
Alongside Boston (water coal), gross tons	6 10@6 85	6.90@7.55

Pocahontas and New River are quoted at $4·70 @5.25 f.o.b. Norfolk and Newport News, Va., for spot coal, and $7.20@8.60 alongside Boston, these prices being on a gross ton basis.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Company Circular		Mine	Company Circular
Broken	$6 05	$7 90	Pea	[illegible] 90	6 65
Egg	5 95	7 80	Buckwheat	3.40	5 15
Stove	6 20	8.05	Rice	2 75	4 50
Chestnut	6.30	8.15	Barley	2.25	4.00

Bituminous

	Spot	Contract
South Forks	$2.90 @ $3 25	$2.95 @ $3.50
Cambria County (good grades)	2 75 @ 2 95	2 95 @ 3 25
Clearfield County	2 50 @ 2 75	2.80 @ 2.95
Reynoldsville	2 50 @ 2 75	2 75 @ 2 95
Quemahoning	2 65 @ 2.85	2 95 @ 3 10
Somerset County (best grades)	2 50 @ 2 75	2 95 @ 3.10
Somerset County (poorer grades)	2.00 @ 2 35	2.50 @ 2 75
Western Maryland	2 25 @ 2 50	2.50 @ 2 75
Fairmont	2.00 @ 2 25	2 35 @ 2 50
Latrobe	2.10 @ 2.25	2 25 @ 2.40
Greensburg	2 25 @ 2 [illegible]5	2 35 @ 2 60
Westmoreland	2 60 @ 2 75	2 60 @ 2 75
Westmoreland run-of-mine	2.35 @ 2.60	2.35 @ 2.65

Quotations at the upper ports for both bituminous and aothracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide		Line	Tide
Broken	$5.95	$7 80	Buckwheat	$3 40	$4 45
Egg	6 05	7 90	Rice	2 75	3 65
Stove	6 30	8 15	Boiler	2.50	3 50
Nut	6 40	8 25	Barley	2 25	3 15
Pea	5 00	6 60	Culm	1.25	2.15

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2 55@$2.75	$3 25
Mine-run	2 35@ 2.50	3 00
Screenings	1 85@ 2.20	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2 45	$2 75	$2 40
Black Creek and Cahaba	3.45	3.75	3.05
Jagger - Pratt Corona	2.85	3.05	2.45
Blacksmith	....	5.25	.....

Domestic quoations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3.95@$4.60
Corona	3.50
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

	Franklin County	Mt. Olive and Stauoton	Standard
Prepared sizes, lump, egg, Nos. 1 and 2 nut	$2 75	....	....
	Williamson County		
Prepared sizes, lump, egg, nut	$2 55	$2 55	$2 00@2 25
Mine-run	2.35	2 20	1.60@1.75
Screenings	2 20	2.05	1.15@1.30
3-in. lump	....	2.30	...
2-in. lump	....	....	1.75@1.90

Williamson-Franklin rate to St Louis is $1.07; other rates 92½c.

New Construction

PROPOSED WORK

N. Y., Belport—The Northern New York Utilities, Inc., plans to build a high tension steel tower transmission line from the company's power house, here, to Towville, about 20 miles. Estimated cost, $200,000. H. G. Davis, Light and Power Bldg., Watertown, Ch. Engr.

N. Y., Binghamton—The Binghamton Light, Heat & Power Co., 172 Washington St., is in the market for a 3000 kw. generator and condenser and a 5000 kw. generator and condenser. R. N. Hodgson, Binghamton, Gen. Mgr.

N. Y., Buffalo—The Robertson Cataract Co., 151 West Mohawk St., will install small boilers in connection with the 6 story, 50 x 100 ft. warehouse which it plans to build. Estimated cost, $80,000. R. L. Fayfield, Iroquois Bldg., Arch.

N. Y., Canton—The Madrid Springs Co., Madrid Springs, is in the market for transmission machinery in connection with rebuilding its factory here, recently destroyed by fire, entailing a loss of $10,000.

N. Y., Rockaway—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will soon award the contract for the construction of a power distributing system at the Naval Air Station here. Estimated cost, $60,000. Specification No. 3958. Noted July 1.

S. C., Orangeburg—The city plans election soon to vote on $70,000 bonds for enlarging and installing additional machinery at the electric power plant. E. Hawes, City Engr.

La., New Orleans—The U. S Naval Station plans to build a central power house on the Mississippi River. Estimated cost, $120,000. Engineering Dept. of the U. S. Navy, Algiers Station, Engrs.

Ohio, Cleveland—The Theunor Norton Provision Co., West 63rd St. and Stock Ave., will install a cold storage plant in connection with building an addition to its factory. Estimated cost, $30,000.

Mich., Detroit—Herman Kramer & Sons, 1697 Gratiot Ave., will install a complete steam plant for heating, motor driven fans and air compressor in connection with the 2 story, 80 x 230 ft. theatre and stores which they plan to build. Total estimated cost, $250,000. C. H. Crane and E. G. Kiehler, 2325 Dime Bank Bldg., Detroit, Arch.

Ill., Chicago—The Mid City Cold Storage Co., c/o A. A. Salzman Engineering Co., Engr., 30 North La Salle St., plans to build a 5 story cold storage plant. Estimated cost, $1,000,000.

Neb., Fall City—The city plans to build a new boiler plant for the water works and electric system. Estimated cost, $50,000.

Neb., Omaha—J. Latenser & Sons, Archts., 632 Bee Bldg., will receive bids until July 20 for the construction of a 1 story, 44 x 110 ft. boiler house on 42nd St. and Dewey Ave., in connection with the University of Nebraska College of Medicine and Hospital, here. Estimated cost, $75,000.

Mo., St. Louis—The Mineral Refining & Chemical Corp., Iron Mountain Tracks and River Des Peres, is in the market for 1 or 2 boilers of 500 aggregate hp. A. Alayo, Gen. Mgr.

Cal., Bakersfield—A. L. Fellows, Federal Irrigation Engr., has reported the project to irrigate lands in Kern River Delta Dist. feasible, and the interested parties have appointed a committee headed by H. T. Miller, Bakersfield, to perfect an organization of irrigation district under state law. The engineer has recommended the acquisition of water rights and distributing systems in the district, construction of a drainage ditch, pumping plants, development of power, etc. District will comprise 684,160 acres, and will probably be known as the Kern River Delta Irrigation District.

Cal., Haywood—The city plans election soon to vote on $228,000 bonds for the construction of a waterworks system, including wells, distributing system, pumps, etc. Olmsted & Gillelen, 1112 Hollingsworth Bldg., Los Angeles, Engr.

Cal., Lancaster—The Board of Supervisors, Los Angeles, plans to form waterworks Dist. No. 4 embracing the town of Lancaster; to include wells, pumping plant, etc. Estimated cost, $30,250. A. M. McPherson, Clk.

Cal., Los Angeles—The Board of Supervisors will soon award the contract for the construction of a psycopathic ward building at the county farm. Plans include the construction of a boiler plant. A M. McPherrin, Clk.

Cal., Los Angeles—The city voted $135,000 bonds for the construction of a sewer system. Plans include the installation of pumps, etc. W. T. Knowlton, City Engr.'s office, Engr.

Cal., Sacramento—The Board of Supervisors plans to build a 2 story power house and service building on the County Hospital Grounds. Plans include the installation of boilers for heating the entire group of buildings. Estimated cost, $100,000. R. A. Herold, Forum Bldg., Arch.

Cal., San Diego—The San Diego Ice & Cold Storage Co. is having plans prepared for the construction of a 4 story, 100 x 200 ft. cold storage plant on 8th St. and Imperial Ave. Estimated cost, $25,000.

Que., Montreal—The Dupre Iron Works, Ltd., is in the market for boilers and dynamos in connection with the factory which it plans to build. P. L. Dupre, 15 Blvd., St. Laurent, Arch.

Ont., Acton—The town has engaged James, Loudon & Hertzberg, Engrs., 36 Toronto St., Toronto, to make surveys and sumbit preliminary report for a complete new waterworks system. Plans include pump house, wells, distributing mains, etc. Estimated cost, $90,000.

Ont., Aurora—W. J. Bassett, Mayor, will receive bids until July 11 for a centrifugal pump having a capacity of 750 gals. per minute, and a gasoline engine. James, Loudon & Co., 36 Toronto St., Toronto, Engr.

Ont., Teeswater—The Town Council plans to install a hydro-electric system for lighting and power distribution system, and is in the market for all equipment for same. A. Flint, 190 University Ave., Toronto, Engr.

Ont., Toronto—The Hydro Electric Power Commission of Ontario, University St., plans to install 5 units (about 60,000 h.p.) power plant and a 200 ft. concrete dam, 43 ft. high, at Cameron Pool. F. A. Hogg, Toronto, Engr.

Ont., Wingham—The Town Council plans to install a hydro-electric system for lighting and power distribution system, and is in the market for all equipment for same. A. Flint, 190 University Ave., Toronto, Engr.

Sask., Regina—The city is in the market for Diesel and gas engines for the power plant.

CONTRACTS AWARDED

Conn., Hartford—The Automatic Refrigerating Co., 89 Willow St., has awarded the contract for altering and building a 1 story, 23 x 76 ft. addition to its plant on Capitol Ave., to Wise & Upson, 36 Pearl St. Estimated cost, $30,000.

Conn., Stamford—The Diamond Ice Co., Main St., has awarded the contract for the construction of a 1 story, 26 x 100 ft. addition to its plant, to the Vuono Construction Co., Bank Bldg. Estimated cost, $15,000.

N. Y., Ossining—C. F. Rattigan, Supt. of State Prisons, Hall of Records Bldg., Center and Chambers St., New York City, received lowest three bids for installing boilers at the Sing Sing Prison here, from J. W. Danforth Co., 70 Ellicott St., Buffalo, $41,847; Lynch & Woodward, 287 Atlantic St., Boston, Mass., $42,945; A. B. Barr & Co., Inc., 30 East 42nd St., New York, $45,800. L. F. Pilcher, Capitol, Albany, State Arch. Noted June 17.

D. C., Washington—The Treasury Department, Office of the Superv. Arch., received bid June 26 for the construction of a boiler house, cafeteria, etc., at the War Industries Building, from W. P. Lipscomb, 1406 G St., N. W., Washington, D. C. (30 days).

W. Va., Benwood—S. G. Smith, Receiver, Wheeling, has awarded the contract for installing motors and pumps at the water works, to the Dravo Doyle Co., Diamond Bank Bldg., Pittsburgh, Penn. Estimated cost, $5743.

S. C., Charleston—The Bureau of Yards & Docks, Navy Department, Washington, D. C., received bids for installing boilers and super-heaters at the Navy Yard here, (work complete), from the Heine Safety Boiler Co., 1120 Pennsylvania Bldg., Washington, D. C., $42,850, (140 days); Edgemoore Iron Co., Edgemoore, Del., $45,217, (120 days); J. L. Skeldon Engineering Co., 242 Water St., Toledo, Ohio, $51,922. Specification No. 3707. Noted Dec. 10.

S. C., Paris Island—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for building an extension to the power house here, to the Newport Contracting & Engineering Co., Law Bldg., Newport News, Va. Estimated cost, $10,385 (60 days).

Fla., Key West—The Bureau of Yards & Docks, Navy Department, Washington, D. C., received ids for the construction of a power house and installing electric operating equipment and fire protection system at the Naval Air Station here, (work complete), from the South Florida Contracting and Engineering Co. Key West, $97,000, (180 days); Newport Contracting & Engineering Co., Silsby Bldg., Newport News, Va., $112,140 (180 days). Noted July 1.

Ohio, Cincinnati—The Treasury Department, Superv Arch.'s Office, has awarded the contract for installing 2 new boilers in the post office and custom house here, to the Heine Safety Boiler Co., 1432 Union Trust Bldg., Cincinnati, $20,430. Noted July 1.

Ohio, Springfield—J. Leffel & Co., Lagonda Ave., has awarded the contract for the construction of a factory on East St., to the Concrete Steel Construction Co., 415 Mitchell Bldg.; plans include a 50 x 150 ft. power plant. Total estimated cost, $500,000.

Wis., Milwaukee—H. C. Fischer & Son, 532 Reed St., has awarded the contract for the construction of a cold storage plant, to H. Koening, 892 Layton Blvd.; contract for refrigeration equipment has been awarded to the Vilter Manufacturing Co., 872 Clinton St., Milwaukee. Estimated cost, $10,000.

Wis., Milwaukee—The T. M. E. R. & L. Co., Public Service Bldg., has awarded the contract for the construction of a 2 story, 60 x 80 ft. power station on 26th and Burnham St. to R. L. Reisinger, First National Bank Bldg.

Wis., Superior—The Board of Education has awarded the contract for the construction of a 2 story, 80 x 200 ft. school with 1 story, 56 x 70 ft. wing, to Hill & Dauplaise, Superior. Plans include the construction of a power house. Total estimated cost, $174,500.

Wis., West Allis—The Board of Education has awarded the contract for the construction of a power house and high school on National Ave., to the Kroening Construction Co., Majestic Bldg., Milwaukee. Estimated cost, $300,000. Noted June 24.

Mo., St. Louis—The St. Louis Manufacturing Corp., 5401 Bulwer St., has awarded the contract for the construction of a 2 story, 96 x 150 ft. power house at 5405-11 Natural Bridges, to A. H. Haeseler B. & C. Co., Wainwright Bldg. Estimated cost, $125,000.

Mo., St. Louis—The St. Louis Wholesale Cut Flowers Co., 1410 Pine St., has awarded the contract for the construction of a refrigerating plant at 1408 Pine St., to the J. Grewe Construction Co., Century Bldg. Estimated cost, $19,000. Noted Apr. 22.

Ariz., Florence—The city has awarded the contract for the construction of a power house and pipe lines, to C. Fisher, 845 North 6th St., Phoenix; for pumping machinery, engine and switchboard, to the Dousman Warner Co., $26,980.

Ore., Prineville—The Standard Oil Co. has awarded the contract for the construction of a pump house, three 16,000 gal. galvanized iron tanks, garage, etc., to O. Wilson, Prineville.

Cal., Anaheim—The City Trustees have awarded the contract for installing pump at the waterworks, to the Krogh Pump & Machinery Co., Los Angeles. Estimated cost, $2410. E. B. Merritt, City Clk. Noted June 3.

Cal., Lemon—G. C. Power has awarded the contract for the construction of a 1 story, 140 x 250 ft. fruit packing house, boiler house, etc., to W. Slater Co., 2314 Santa Fe. Ave., Los Angeles. Estimated cost, $70,000.

Cal., Vernon—The California Provision Co. has awarded the contract for the construction of a 2 story, 88 x 142 ft. packing house and refrigeration building, a 20 x 32 ft. boiler house, and 32 x 32 ft. office building, etc., to C. B. Harp, 1102 Baker-Detwiller Bldg., Los Angeles. The company will soon award the contract for furnishing machinery and equipment, including a 25-ton refrigeration plant, boilers, etc. Total estimated cost, $150,000.

Que., Three Rivers—The Three Rivers Cold Storage Co. has awarded the contract for the construction of a cold storage plant, to Arsenault & Plamondon, Ltd., 70 St. James St., Montreal. Estimated cost, $75,000.

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See pages 303 to 331 this issue

POWER

Volume 50 New York, July 15, 1919 *Number* 3

Heads Win

The other day on a street corner, I saw two little newsboys matching pennies. As I passed, one of them shouted, "Heads win!"

That little ragged urchin did not realize that he was proclaiming a great truth. But he was.

Time was when money was looked upon as being the chief factor in every branch of life. The capitalist was looked at with envy, and sometimes with fear. That day is fast passing away. People know differently now. It is headwork that wins today.

In the great world war it was not the money, the men, the tremendous amount of ammunition, the submarines, which won. It was brains. If the enemy produced a deadly gas, then the brains of the opposing forces were set to work to produce a gas more deadly than the other. When the submarines began to take their daily toll of ships sunk and destroyed, the allied nations realized that they must think out a way to get rid of these reptiles of the sea. And they did it. The magnificent brain of Foch and his generals planned a campaign which wore down the German hosts and in the end accomplished their defeat. Brains did it, not guns. Heads won.

In the industrial world it is not the man with the biggest muscles that gets to the top. It is not the man with massive arms and iron hands, who can lift a hundred-pound weight with ease, who gets the most money in the pay envelope at the end of the week.

It is the man whose brain is active, who thinks and plans and studies the best way to do a job. It is the man of power. And power does not mean brute force. Power comes from constructive thinking, cumulative thought or, in the parlance of the street, "using your head."

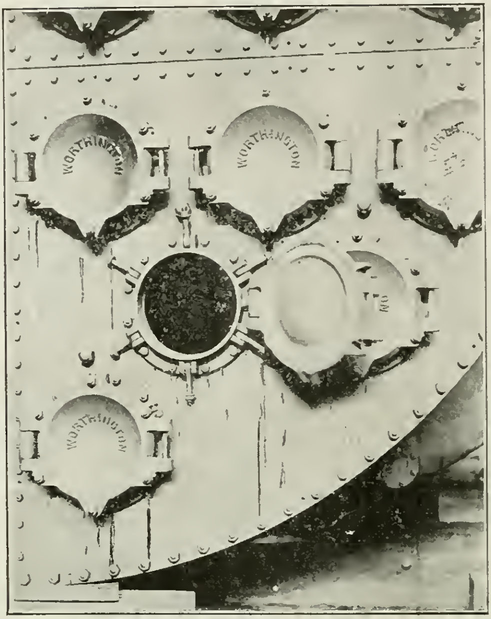
Some weeks ago a Foreword appeared in *Power* on "The Passing of the Boss," which was full of common sense and truth.

Why is the "boss" passing? Because men are beginning to think for themselves. The day when they were driven or led to do things by soft words and unctuous phrases has gone by. Today men in all branches of industry are fast thinking out their problems without help from others. They are using their heads and they glory in it. Just in proportion as they learn to think for themselves will men grow in power to do and live and prosper.

The next time you hear a man grumble over the amount he gets in his pay envelope, tell him the story of the newsboy who unwittingly emphasized the great truth, "HEADS WIN."

Contributed by FRANK DORRANCE HOPLEY.

Particulars of a 56,000 Sq.Ft. Surface Condenser



WHILE not the largest surface condenser built, the one described herewith has, in common with other large ones constructed for recent installations, many features of interest. It is of the Worthington type and has a total of 56,000 sq.ft. of tube surface, including that for the heater; there are 54,500 sq.ft. of condensing surface and 1500 sq.ft. for the heater. The tubes and tube plates are of Muntz metal, the condenser going into service in one of the large power stations of the Middle West, for the circulating waters of which this metal is well suited. The condenser will serve a 35,000-kw. turbine and will be placed in rather crowded quarters. This accounts for the short shell, which is but 15 ft. 3 in. long by 21 ft. 9 in. in diameter inside, 23 ft. outside flange diameter. The tube heads are 18 ft. 8 in. in diameter by 1½ in. thick. There are 14,280 one-inch tubes, 15 ft. 6¼ in. long, 384 of which are in the heater. Empty, the condenser weighs 700,000 lb., and it will contain 130,000 lb. of water, giving a total weight of 830,000 lb. The castings for the shell of such a condenser, unlike structural castings of like size, must be water-tight; there must be no spongy spots. The foundry where these castings were made—that is, at the Harrison, N. J., works of the builder — is particularly proud of them because they not only look pleasing but are sound everywhere, and these were the only castings made for this condenser. The circulating pump is a 48-in. double-suction volute of 60,000

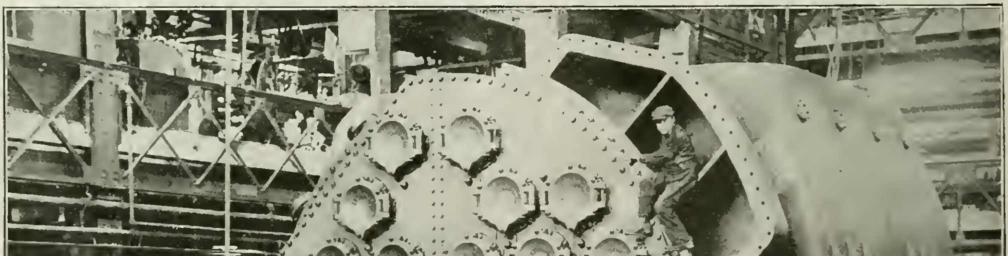


FIG. 1, BELOW. A 56,000-SQ.FT. SURFACE CONDENSER FOR A 35,000-KW. SINGLE-SHAFT TURBINE. FIG. 2, ABOVE. TYPE OF DOOR FOR WATERBOXES.

gal. per min. at 20 ft. head and 300 r.p.m. The suction is 54 in. in diameter, with 48-in. delivery. It will be driven by a 435-hp. 25-cycle three-phase 220-volt G. E. motor. Three No. 10 hydraulic vacuum pumps, arranged for use of one, two or three units, are provided. Two combined units, driven by Westinghouse turbines, will handle the condensate and vacuum pump water. Each of these units has a 10-in. split-casing single-stage double-suction pump delivering water to the hydraulic vacuum pumps, and a 6-in. split-casing two-stage condensate pump. These pumps and the turbine are all mounted on the same bedplate. Each turbine is of 166 hp. capacity. A feature of the condenser is the type of door used in the shell heads and shown in Fig. 2. This door is concave, giving considerable strength for comparatively small thickness in the concave area, yet providing a heavy rim to contain the canvas-rubber gaskets. The door may be attached so as to swing either right or left. Each nut on the swinging studs has a washer cast integral with it. Of course the station crews readily appreciate the convenience of this feature. The condenser is supported on duplex coil springs—the 8-in. outside diameter, 1½-in. section spring having a 4⅞-in. outside diameter, $\frac{15}{16}$-in. section spring inside it, as shown in Fig. 4. The large springs are 7¾ in. long when uncompressed and 6 in. when compressed. Beneath each spring guide-pin (cast steel) is a 10-in. jackscrew, 3½ in. outside diameter, 6 threads per inch. Each jackscrew engages 4 in. of threads or 24 threads in the spring support, each one of which is 4 ft. 8 in. long by 2 ft. 11 in. wide, of cast iron.

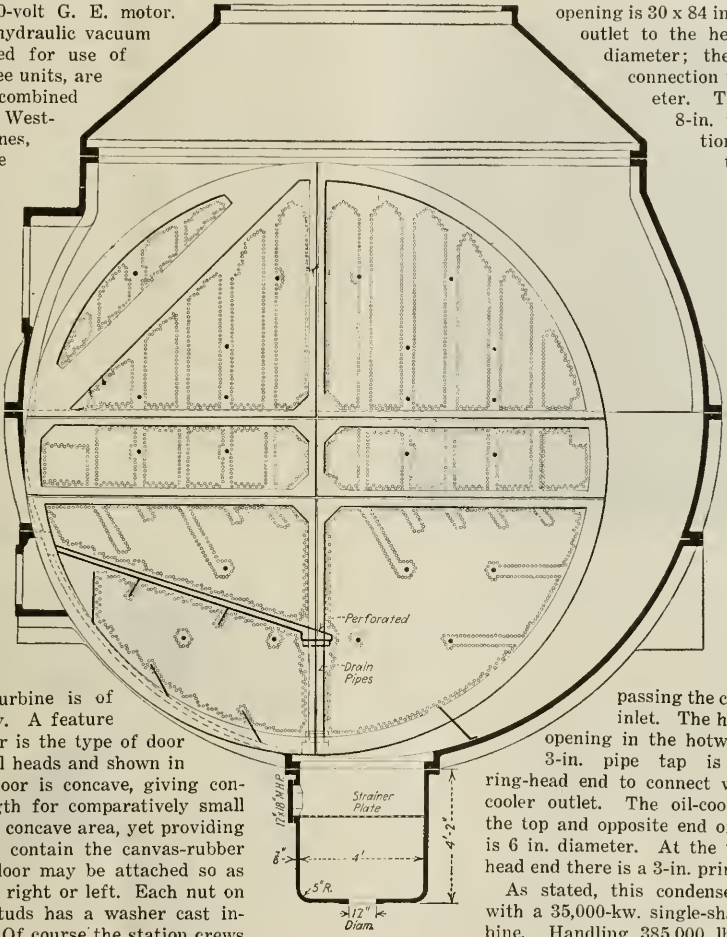


FIG. 3. TUBE ARRANGEMENT, BAFFLES AND HEATER TUBES

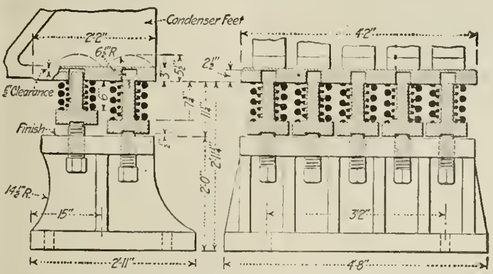


FIG. 4. CONDENSER-SUPPORTING SPRINGS

The area of the exhaust opening into the condenser is roughly 133 sq.ft. The free exhaust opening in the shell is 42 in. in diameter; the air-pump suction opening is 20 in.; the circulating-water opening is 30 x 84 in. Both inlet and outlet to the heater are 10 in. diameter; the makeup-water connection is 5 in. in diameter. There also is an 8-in. makeup connection into the bottom of the circulating-water connection for hydraulic vacuum pump hurling water makeup. Through this connection water will be supplied for keeping down the temperature of the hurling water to the hydraulic vacuum pumps, so the water may be kept at a temperature but little higher than that passing the circulating-water inlet. The hot-water suction opening in the hotwell is 12 in. A 3-in. pipe tap is made in the ring-head end to connect with a 3-in. oil-cooler outlet. The oil-cooler overflow, at the top and opposite end of the condenser, is 6 in. diameter. At the top of the ring-head end there is a 3-in. priming connection.

As stated, this condenser will be used with a 35,000-kw. single-shaft impulse turbine. Handling 385,000 lb. of steam per hour, the vacuum maintained with circulating water at 70 deg. F. will be 28.4 in. mercury with 60,000 gal. per min. circulating. With 45-deg. circulating water, other conditions the same, a vacuum of 29 in. mercury will be maintained.

There follow some chief data concerning the condenser, Fig. 3, shows able for inserting in one's notebook.

The diagram of the condenser, Fig. 3, shows clearly the arrangement of tubes to provide steam lanes. The writer believes that in this large condenser a greater number of these lanes are provided than is customary with large condensers. The lower tubes become more effective.

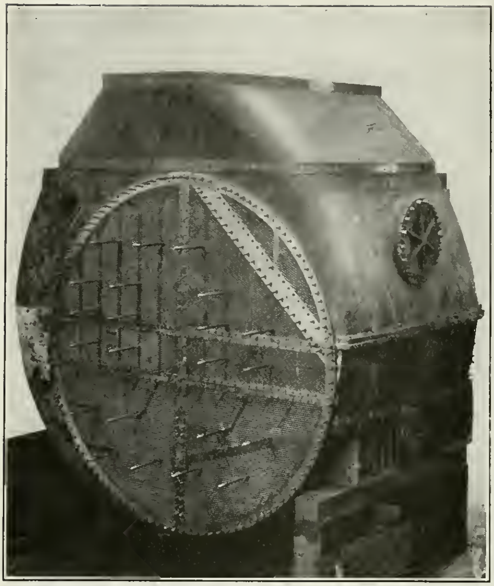


FIG. 5. THE CONDENSER WITH WATER BOXES REMOVED

DATA ON WORTHINGTON CONDENSER FOR 35,000-KW.
SINGLE-SHAFT TURBINE

Length of shell	23 ft
Diameter, inside...	21 ft. 9 in
Material of tubes and tube heads	Muntz metal
Total tube area, sq.ft	56,000
Condensing area, sq.ft	54,500
Heater area, sq ft.	1,500
Tubes, 1 in. diameter, 18 gage B w g	.....
Weight condenser, empty, lb.	700,000
Weight condenser with water, lb.	830,000
Weight condenser with water per rated kw. of turbine, lb.	23.8
Tube area per rated kw. capacity of turbine, sq.ft.	1.6
Tube area of heater per rated kw. capacity of turbine, sq.ft	0.043
Condensing tube area per sq.ft. heater-tube area, sq ft	36.2
Water circulated per lb. steam condensed at rating, lb.	78
Circulating-water pumping capacity per rated kw turbine capacity, gal per min.	1.43
Heat transmission per sq.ft. tube area per deg. difference inside and outside of tube, B.t.u. per hr. (estimated)	400 to 420
Circulating-water pumping capacity per sq.ft. total tube area, gal. per min.	1.07
Condensate pumping capacity, gal. per min., maximum	1,200
Condenser support	Duplex helical springs

Surface Condensing Plant Temperatures

By Mark Meredith

When tuning up surface condensing plants, it is highly desirable that, having a good vacuum, the hotwell-water temperature should be kept as high as possible consistent with that vacuum, and a little trouble taken to regulate the cooling-water supply to suit the load on the condensing plant will be amply repaid.

There should not be more than 10 deg. F. difference between the hotwell-water temperature and the theoretical temperature:

Vacuum, In.	Theoretical Temperature, Deg. F.
20	161.28
21	156.83
22	151.97
23	146.55
24	140.42
25	133.32
26	124.89
27	114.34
28	100.05

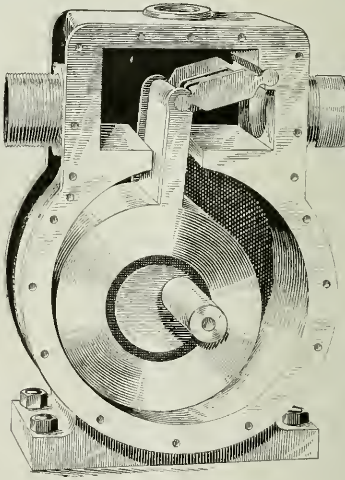
A difference of more than 10 deg. F. indicates either air leaks in exhaust main, inefficient air pump, or if vacuum is high too much cooling water passing. There should not be more than 15 deg. to 30 deg. F. difference between hotwell temperature and the cooling-water discharge temperature. A high difference indicates either an excess of cooling water or a dirty condenser. The former is shown by low hotwell temperature, the latter and more usual by high hotwell temperature. A low vacuum with a high temperature in both hotwell and circulating-water discharge shows that insufficient circulating water is passing and may be due to the centrifugal pump running at wrong speed or to its impeller being worn.

It should also be remembered that, although steam turbines require as high a vacuum as can be obtained, to achieve the best results as regards coal consumption, reciprocating engines generally give their best results with about 25.5 to 26 in. vacuum, the hotwell temperature being kept as near as possible to the theoretical temperature.

Thompson Return-Line Vacuum Pump

In a vacuum heating system the condensation from the radiators, together with the air, is drawn by suction to a pump, where the air is separated from the water, and the hot water is returned to the boiler or to a receiver. Naturally, a vacuum pump should be simple in construction, quiet in operation and durable.

The illustration shows a pump that has but three moving members, the crank and the impeller, and a hinged plate, the purpose of which is to separate the suction and the discharge side of the pump cylinder. The surfaces of the impeller and the pump casing are cylindrical, and the impeller is at no time in contact with the casing, a very close clearance being maintained. The crankshaft of the impeller is fitted with ball bearings, and as the crank turns in a clockwise direction, it gives the impeller an eccentric motion. As the water enters the inlet pipe it discharges into the space between the rotor and the casing, and as the rotor revolves this water is carried around until it escapes through the discharge pipe. This pump is being manufactured by the Thompson Manufacturing Co. of Des Moines, Iowa.



SECTION THROUGH VACUUM PUMP

Characteristics of Illinois Coal and How To Burn It

By T. A. MARSH
Chief Engineer, Green Engineering Co., East Chicago, Ind.

Coals of Illinois by the bed and the district. Relative values as steaming coals, their characteristics and analyses. Types of furnaces best adapted to burning these coals smokelessly and at high efficiency on the chain grate.

During the year 1918 Illinois produced over 88 million tons of coal, ranking as third state in coal production. All this coal is bituminous, or in nontechnical terms, smoky, free-burning, "clinkery" coal, having ash that fuses at a relatively low temperature. There are five definite producing coal beds in the state, but a discussion of Illinois coal becomes more simple when it is learned that 90 per cent. of all coal produced comes from two beds, and but little consideration need be given to the others.

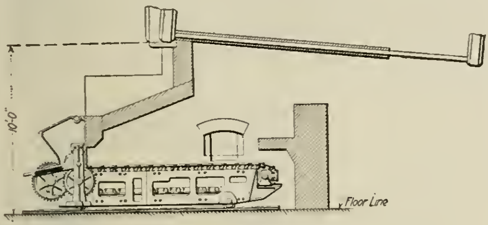


FIG. 1. TYPICAL FURNACE FOR HORIZONTALLY BAFFLED BOILER

Knowledge of the bed alone is not an exact criterion of the quality of coal. However, the quality produced from any bed in a given district is fairly uniform, so that a knowledge of the district and the bed identifies a coal. On this basis there are nine coals to consider in Illinois. A tabulation of these coals with typical analyses of their screenings, including the fusion temperatures of the ash, is given in Table I. These analyses being based on screenings, contain approximately 2 to 4 per cent. more ash than mine-run samples and 3 to 6 per cent. more than lump samples. It is attempted in these analyses to represent the average of the seam in the districts. Many mines, therefore, in large districts produce better coal. For instance, in the Herrin district, mines in some localities give screenings from No. 6 coal with less than 10 per cent. ash and 1 per cent. sulphur.

Coal from No. 1 bed is mined most extensively in the Rock Island district, although in Christian County some is mined which contains approximately 2 per cent. less sulphur than that of the Rock Island district.

Coal from No. 2 bed is mined in two districts, La Salle and Murphysboro. As produced at La Salle, screenings are high in ash and sulphur, as the seam is thin. Most steam producers in the district consider this coal uncommercial. Notwithstanding, it can be burned in furnaces of proper design and is now giving satisfaction up to 200 per cent. of rating in furnaces of the type shown in Fig. 3.

As regards ash and sulphur content Murphysboro No. 2 is the purest coal produced in Illinois. Lump samples frequently contain 14,000 B.t.u. on the dry basis, an exceptionally high figure for Illinois coal. The excellent quality of this coal practically eliminates it from the steaming-coal market, as it is in high demand for domestic and other purposes.

No. 5 coal is produced in the Harrisburg and the Springfield districts. Of these the former is by far the better coal, its high heat value and the relatively high fusion point of the ash making it a desirable fuel for those plants having limited boiler capacity. Springfield, or Central District No. 5, coal has a softer structure than that from the Harrisburg district. Its high ash and sulphur contents, lower fusion temperature of the ash and lower heat value make the use of this coal prohibitive in many steam plants. It is unsuitable for stokers not having a continuous ash discharge from the furnace, as it tends to clinker badly if the fuel bed is agitated.

Either the Harrisburg or the Springfield No. 5 coal is excellent chain-grate fuel. When designing a stoker for Springfield coal, it is customary to allow more liberal grate area and to provide longer ignition arches than for Harrisburg No. 5. In some localities, however, the Harrisburg coal becomes more expensive per 1000 lb. of steam, as, owing to its superior qualities, it commands a higher price than Springfield coal.

No. 5 coal is produced also in the Peoria district, but its heat value is so low, because of the high ash content, that comparatively little of it is used in steam plants and much coal for the Peoria market is imported from the Springfield district. This is an economical loss, as it is possible to obtain good efficiencies and capacities with the Peoria coal provided furnaces are designed properly.

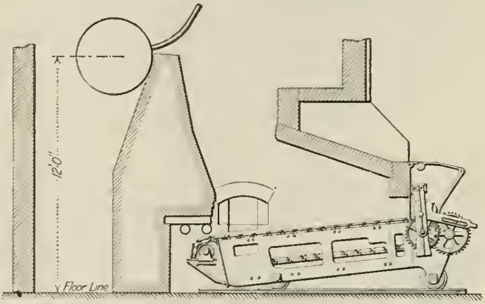


FIG. 2. DESIRABLE FURNACE FOR STIRLING BOILER

Coal from bed No. 6 of Illinois also has a wide range in quality and characteristics according to the locality in which it is mined. The coals of the Bellville district have limited utility and low heat value, while the Franklin county No. 6 coal is an excellent fuel.

The coals of the Herrin district have become more widely known than any other Illinois coals, due to their comparatively low ash and sulphur contents and their relatively high ash-fushion point. Clinker trouble may be reduced by the use of these coals, but plants limited to these fuels, either due to inadequate boiler capacity or grate area or to clinker trouble, have to contend with high steam costs, as the price of coal is higher than would exist if the entire coal market were open to them.

No. 6 coal produced in the Bellville district is high in ash and sulphur and has a low fusing point. It forms a plastic, sticky clinker, difficult to handle when once formed. Coals from this district are known in St. Louis as the "inner group." The relatively low heat value and long haul prohibit marketing these coals in Chicago except under abnormal market conditions.

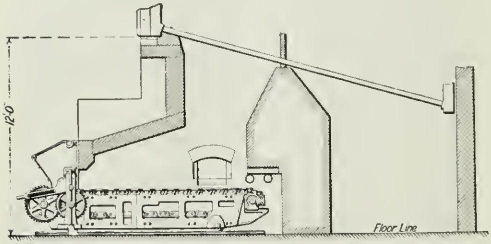


FIG. 3. VERTICALLY BAFFLED B. & W. BOILER

In bed No. 7, usually known as the Danville coal field, production has been largely a stripping process, so that the coal is high in ash. The sulphur content also is high.

In general, from a combustion standpoint, Illinois screenings may be described as smoky, clinkery, high-ash coals of about medium heat value as compared with the best and the poorest coals in the country. Yet in spite of their abnormal characteristics, Illinois coals are being burned without producing smoke and are being handled with a greater freedom from clinker than is normal in Eastern plants with the highest-grade fuels. In spite of the high percentage of ash fires are kept clean, and notwithstanding the low heat value boilers are operated at from 200 to 250 per cent. of rating, which is in accord with good, modern practice.

These facts emphasize the progress of combustion engineering. It has been necessary to burn these coals and without smoke in many districts. Clinker trouble was serious with hand firing and with stokers designed for Eastern coals, so that stokers had to be developed to eliminate this trouble and also to remove the high percentage of ash carried by this coal. The chain grate has been found suitable to meet these conditions.

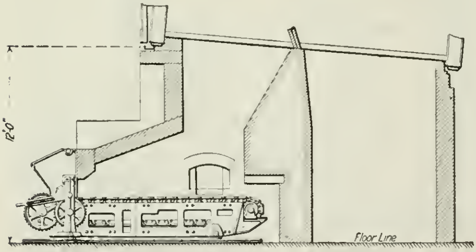


FIG. 4. EFFICIENT FURNACE FOR VERTICALLY BAFFLED EDGE MOOR BOILER

Efficiencies during the development period were not high; 65 to 68 per cent. was considered good practice. It was largely a question of furnace design. Improved furnaces permitting complete combustion of the hydrocarbons, of which there is such a large percentage in Illinois coals, have increased the efficiency until 72 to 75 per cent. is as commonly obtained now as the lower range ten years ago.

Table II gives some chain-grate performances with Illinois coals, indicating the results that are obtainable. It will be noticed that in test No. 2 a combustion rate of 48.21 lb. of coal per square foot of grate area per hour over a period of four hours, while developing 244 per cent. of rating continuously, was maintained. Higher ratings were carried for short intervals, and peaks of steam output could be carried in excess of this rating.

To produce cheap power, it should be possible to burn all coals available to the market in which the plant is located. The necessity of picking certain coals or of importing coals from a remote district is usually an expensive necessity. In many instances existing plants are unable to burn all coals in the market. The selection of stokers, their proportions and the furnace design should take into consideration the quality of coal to be utilized in the locality, making it unnecessary to select certain better fuels in order to get satisfactory operation.

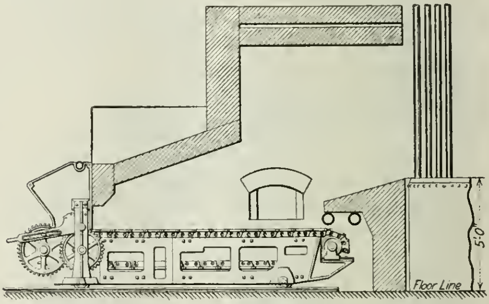


FIG. 5. FURNACE FOR VERTICAL BOILER

Some typical furnaces of desirable proportions for Illinois coals are shown in the accompanying drawings. All boilers are shown set at heights to give large furnaces.

Fig. 1 indicates a horizontal baffled boiler with a typical furnace for Illinois coals. Even in the early stages of the art of smokeless combustion this furnace was known to be smokeproof up to high overloads. The ample proportions of furnaces as installed today render this furnace smokeless up to and even beyond 250 per cent. rating of the boiler. Fig. 2 shows a Stirling boiler with a desirable furnace for Illinois coals. Figs. 3 and 4 show furnaces for vertical baffled boilers. These furnaces have the same smokeless characteristics as the design shown in Fig. 1. The furnace shown in Fig. 5 is used with vertical boilers. These boilers lend themselves readily to full dutch-oven furnaces that make complete combustion and smokelessness easy to obtain.

In all these designs the arch lengths and grate areas are dependent on the coal to be used. The furnaces shown are more liberally designed than those required for smokelessness and therefore will operate at better efficiencies than would be the case if minimum dimensions for smokeless operations were used. It is now known to be common practice with chain grates to obtain 70 per cent. efficiency and upward without smoke when operating at 200 per cent. of rating.

The important points to remember in connection with this consideration of the combustion of Illinois coals are:

1. The coal produced from any of the Illinois seams in the southern part of the state is better than that produced from the same seams in the northern part.
2. Of all coal produced in Illinois, 90 per cent. comes from seams Nos. 5 and 6.
3. Coal is frequently imported into an actual producing district where it is burned in preference to the local product. Such districts are notably La Salle, Peoria and Belleville. This is an economic waste and should be corrected by the installation of suitable furnaces for burning the local coal.
4. Even the poorest coals of the state are being burned at 200 per cent. of rating and beyond with good efficiencies.
5. Chain grates are particularly well adapted for all Illinois coals, owing to the absence of clinker troubles.
6. Smokelessness with chain grates using Illinois coals can be assured.
7. Higher efficiencies are being obtained by using furnaces more ample than the minimum requirements for smokelessness.

TABLE I. TYPICAL ANALYSES OF ILLINOIS SCREENINGS BY DISTRICTS AND BEDS

Coal by District and Bed	Moisture	Volatile	Fixed Carbon	Ash	Sulphur *	B.t.u. Commercial	B.t.u. Dry Basis	Fusion Temp. of Ash
District No. 1......	11.92	33.28	34 64	20 16	4 50	9,509	10,796	2,025
La Salle Co. No. 2 coal								
District No. 2......	9.28	31.97	49.00	9 75	1 29	11,975	13,199	2,425
Jackson Co. No. 2 coal								
District No. 3......	13.46	34.5	34 54	17 5	4 8	9,808	11,334	2,050
Rock Is. and Mercer Co. No. 1 coal								
District No. 4......	13.00	34.8	37.00	15.2	4 5	10,353	11,900	2,179
Springfield Nos. 5 and 6...........	12.2	33.2	35.00	19.6	4 00	9,719	11,070	
Peoria No. 5 coal								
District No. 5......	6.75	33.49	46.72	13.04	3 00	11,493	12,325	2,291
Harrisburg No. 5 coal								
District No. 6......	8.00	33.00	45 5	13 5	2 25	11,362	12,350	2,350
Herrin No. 6 coal								
District No. 7......	12.56	34.00	34 44	19 00	4 80	9,813	11,222	2,091
Belleville No. 6 coal								
District No. 8-a....	14.45	36.55	36.00	13.00	2 55	10,500	12,274	2,175
Grape Creek No. 6 coal								
District No. 8-b....	12.99	35.55	35.0	16 46	2.93	10,070	11,575	2,125
Danville No. 7 coal								

* Separate determination.

TABLE II. CHAIN-GRATE PERFORMANCE WITH ILLINOIS COALS

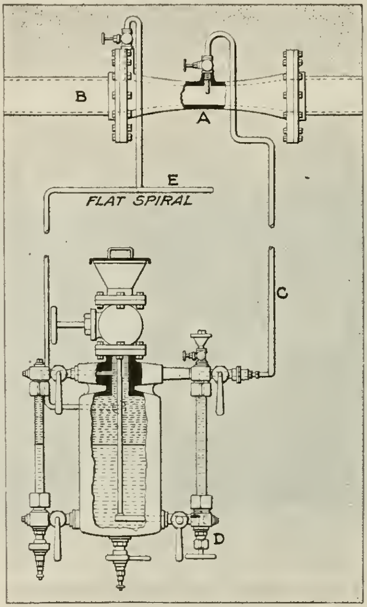
Test No.	1	2
Type of boiler	Stirling	Edge Moor
Type of grate	Green-type K	Green-type K
Area of grate, 29-ft	99	100
Ratio of grate area to heating surface	50.66	52 8
Duration of test, hours	8	4
Horsepower rating of boiler	501	528
Name of fuel	Harrisburg No. 5	Franklin No. 6
Size of fuel	1½-in. screenings	Screenings
Moisture, per cent	9.5	5 6
Volatile, per cent	30.01	26
Fixed carbon, per cent	50.94	53 6
Ash, per cent	11.35	12.1
Sulphur, per cent	3.79	..
B.t.u., commercial	12,000	11,572
B.t.u., dry basis	13,270	12,250
Furnace draft, in	0.34	0.58
Uptake draft, in	0.73	1 37
Coal per square foot of grate area per hour, lb	31.4	48.21
Per cent. rating developed	164	244
Combined efficiency, per cent	74.74	71.25

Business secrets used to be considered a large part of the stock in trade, to be jealously guarded from all competitors. More recently it has become evident that such secrets were of but small value, in no way comparable to the profits to be obtained from the application of new ideas worked out by one individual to the trade as a whole.

Meyeringh Proportional Lubricator

The ordinary hydrostatic lubricator, the regulating valve once set, supplies the steam in the line to which it is connected with the same amount of oil independent of the number of revolutions of the pump or engine by which the steam is consumed, thereby providing lubrication that is not always in proportion to the load.

With the proportional lubricator, as shown in the illustration, the quantity of oil fed to the steam line is automatically kept proportional to the quantity of steam flowing through the line. It comprises an oil reservoir, a condensation pipe formed as a flat spiral and a nozzle interconnected as indicated. As the velocity of the steam flowing through the nozzle is higher in the contracted part *A* than in the full diameter *B*, the gage pressure will be higher at *B* than that at *A*, thus forcing oil from the lubricator through the oil pipe *C* into the steam line. The difference in gage pressure between *B* and *A* is such that the quantity of oil flowing through the regulating valve *D* will be proportional to the quantity of steam flowing through the steam line.



PROPORTIONAL LUBRICATOR AND CONNECTION TO NOZZLE

The condensation spiral *E* is so proportioned that all steam entering this line is condensed. Above the spiral the small line is filled with steam, and when the latter part is well insulated, no condensation will take place in it. By this device the hydrostatic action on which the hydrostatic lubricator is based is eliminated and only such forces work in the oil receptacle as give proportional lubrication. The advantage of the device is that it can be installed in a main steam line feeding one or more pumps and engines at the same time.

The proportional lubricator is put out by the Oil Well Supply Co., Pittsburgh, Penn.

Reverse-Current Relays—Principles of Operation

By VICTOR H. TODD

ONE of the problems confronting the users of direct-current apparatus is how to protect a circuit or piece of apparatus from damage due to reversal of current or power. For example, a storage battery when connected to a station bus will motorize the generators if their voltage should drop below that of the battery; or when rotary converters are operating in parallel, if the alternating-current power to one machine fails, the unit will be run as a direct-current motor by the other machines on the system. In conditions of this kind the ordinary overload-type circuit breaker will not trip out, because there is no overload; it is therefore necessary to provide a relay that closes its contacts and trips the breaker when the current reverses. Fig. 1 shows such a relay with the cover removed, and Fig. 4 is a diagrammatic scheme of connections.

In Fig. 4, *A* is the magnet frame and *B* an iron core about which the moving coil *C* is free to turn on jeweled bearings at the top and bottom of the coil, very similar to the permanent-magnet movement voltmeter or ammeter. The field coil *D* is wound with a large number of turns of fine wire connected directly across the circuit and magnetizes the polepieces *N* and *S*. It will be noticed that the potential on coil *D* does not reverse, no matter which way the current is flowing in the circuit; consequently, the polarity of the magnet is always the same. The movable coil is connected through spiral springs, the same as a movable coil in a direct-current ammeter or voltmeter, to the shunt, which is in series with the load. When the current flows in the proper direction, the turning effort, or torque, of the movable coil tends to keep the contact *E* firmly against the stop *F* and is also held in this position by the spiral springs. But if the current reverses in the circuit, the current through the movable coil is reversed, consequently the torque, therefore contact *F* moves over against *G*. This closes a circuit to the shunt trip on the circuit-breaker and opens the circuit. Or if desired, it may close a definite time-limit relay, which in turn closes the trip circuit. The position of the stop *F* and the contact *G* is variable, so that the contacts will not close until the load has reversed to a definite predetermined amount. This relay has a scale marked in millivolts, as shown in Fig. 1, and may be set to act as low as 2 per cent. reversal of current or as high as 100 per cent.

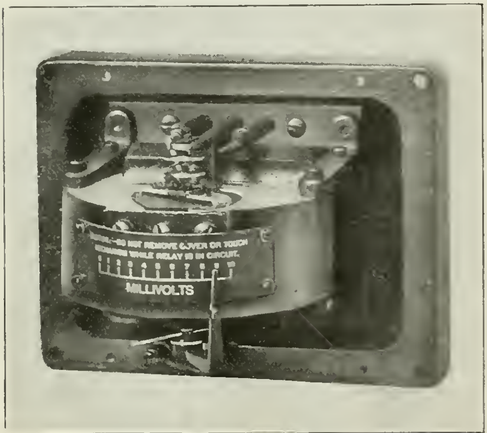


FIG. 1. MOVABLE-COIL TYPE REVERSE-CURRENT RELAY

The closing torque of this relay is proportional to the load, owing to the restraining effort of the spiral springs, consequently can be used as an excess-current relay since its time is inversely proportional to the excess current. Thus if the disturbance is mild, it may take as high as 8 seconds to close, allowing ample time for a transient disturbance to clear itself. If the disturbance is more severe, it may take only 1, 2 or 4 sec., depending on the violence of the disturbance, while on a dead short-circuit the action in closing the contacts is almost instantaneous.

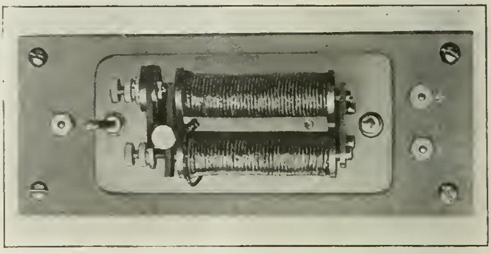


FIG. 2. POLARIZED REVERSE-CURRENT RELAY

Fig. 2 shows another type of reverse-current relay, which is not, however, capable of such accurate protection. A schematic diagram of this relay is given in Fig. 5. *A* is a permanent bar magnet, with poles *N* and *S*. Pivoted on the end of the magnet is an iron armature *B* which has its ends polarized *N′* and *N′* by magnetic induction. The iron cores of coils *C* and *D* also serve to complete the magnetic circuit of the bar magnet. The coils are wound to produce poles *N* and *S* at the armature end with the current flowing in a normal direction. Then the *N* end of the lower coil repels the armature *N′* and the *S* end of the upper coil attracts the

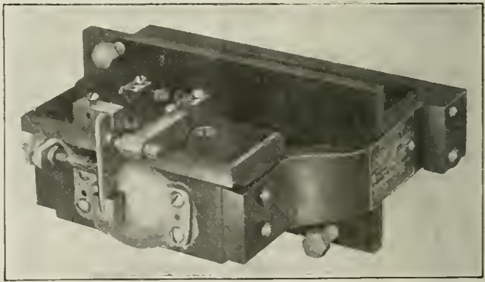


FIG. 3. REVERSE-CURRENT RELAY ARRANGED FOR BUS-BAR MOUNTING

armature. This keeps the contacts *E* and *F* open. Should the current reverse, the polarity of the electromagnets is reversed and the armature end of the lower coil will become *S* polarity, which will attract the armature *N′* while the upper coil will become *N* and will repel the armature *N′*; therefore the armature moves over and closes the contacts *E* and *F* on reversal of the current, which in turn may close the circuit to a relay switch, definite-time-limit relay or the shunt-trip coil on the circuit-breaker.

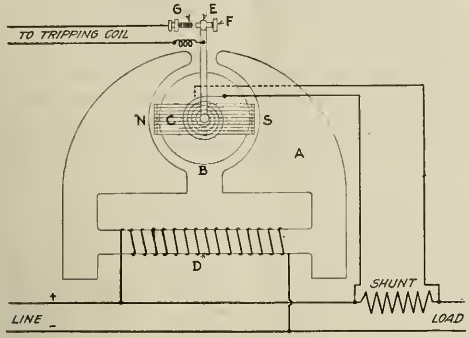


FIG. 4. SCHEMATIC DIAGRAM OF THE MOVABLE-COIL TYPE RELAY SHOWN IN FIG. 1

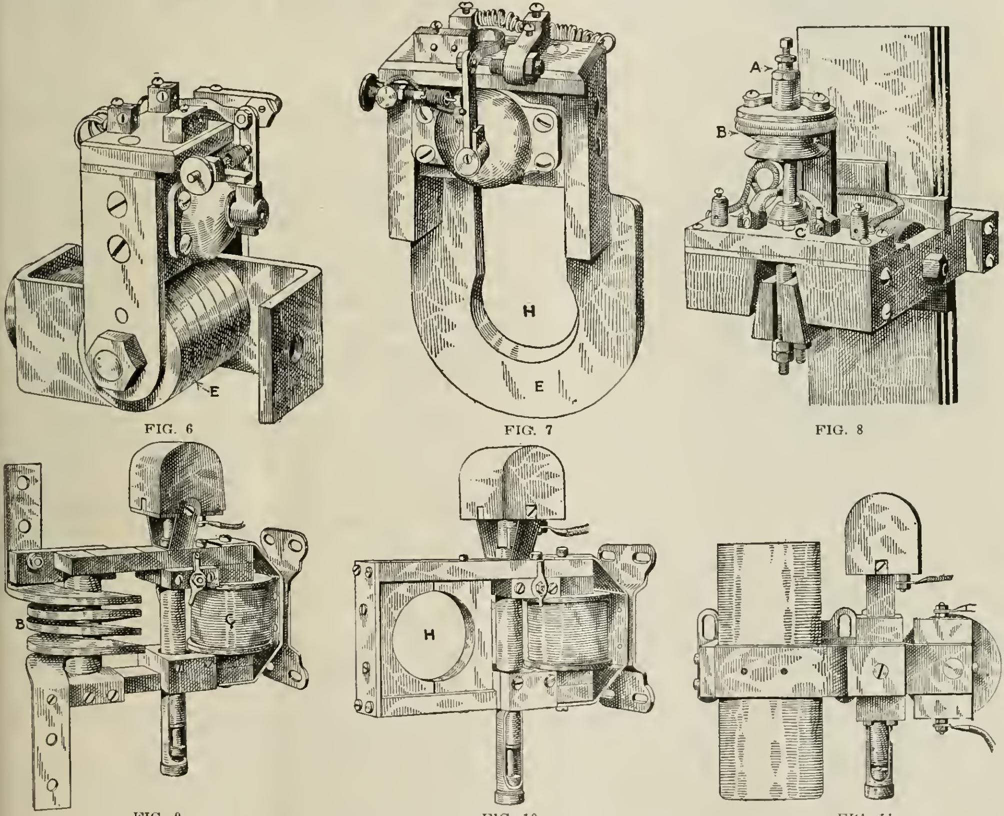


FIG. 6 FIG. 7 FIG. 8

FIG. 9 FIG. 10 FIG. 11

FIGS. 6 TO 11. DIFFERENT TYPES OF REVERSE-CURRENT RELAYS

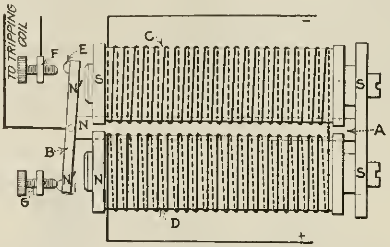


FIG. 5. SCHEMATIC DIAGRAM OF REVERSE-CURRENT RELAY SHOWN IN FIG. 2

The relay may be adjusted to operate on a definite reversal by changing the position of the stop *G* or by varying the millivolt drop across the relay-coil leads. The millivolt drop may be obtained by connecting across a length of copper busbar. Allowing 1000 amperes per square inch of cross-section, 6-ft. length of busbar will give 50 millivolts drop. A correspondingly heavier current per square inch will give the drop with a shorter span. Care must be taken that the relay leads span only the solid copper—that is, there is no joint included—as a slight resistance of a joint may equal several feet of busbar and the resistance of a joint is generally unstable. The drop obtained in this manner will vary greatly with the heat, as the resistance of copper increases with a rise in temperature. This, however, should cause no trouble, as reverse-current relays should never be set or reliance placed on a setting when a variation of 5 to 10 per cent. might mean the difference between correct and incorrect operation.

In Fig. 6 is shown a type of reverse-current relay that has its current and potential coil reversed from that in Figs. 1 and 2. The exciting coil *E* is wound with heavy copper strap, and the movable coil located in the upper part of the relay is wound with fine wire placed in series with a resistance and forms the potential element, or in other words, is connected across the circuit.

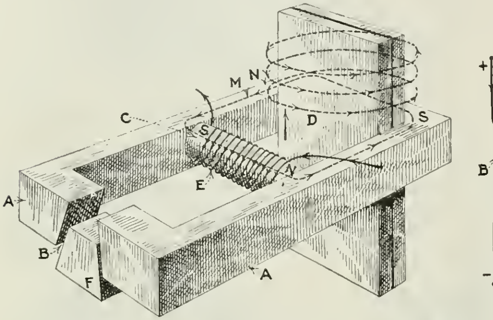


FIG. 12. SCHEMATIC DIAGRAM OF REVERSE-CURRENT RELAY FIG. 8

In the relay shown in Fig. 7 the current coil is dispensed with, as the iron yoke *E* forms the winding and gives enough magnetism for operation simply by passing the circuit-breaker stud or terminal, where the relay is mounted, through the hole *H*. Fig. 3 shows a similar type, but is arranged for mounting on a busbar. The reverse-current relay, Fig. 8, operates on a somewhat different principle from those in Figs. 3, 6 and 7. This is shown diagrammatically in Fig. 12. The iron magnetic circuit *A* has a gap *B* on one side and an iron yoke *C* across its center. If the current in the heavy busbar *D* is flowing in the direction of the arrow, it will magnetize the yoke of a polarity as shown. The winding *E* is wound with a large number of turns of fine wire and is connected across the circuit so as to produce a polarity in core *C*, as indicated. It is evident that the effect of the current in the busbar and that in coil *E* is such as to cause a flow of flux through the magnetic circuit formed by the magnet *A* and the yoke *C* of the potential coil *E*, as indicated by the dotted line *M*. Very little magnetism will flow through the part of the magnetic circuit containing the air gap *B*. Should the current reverse in the busbar, however, the magnetism will also reverse and oppose that of coil *E*, but they will both unite in forcing the magnetism through the part of the circuit containing the air gap *B*. In air gap *B* is an iron core *F*, and when the magnetism becomes great enough, the core will be attracted upward, thus closing the contacts *C*, which are shown clearly in Fig. 8. This type of relay is given an inverse-time characteristic by equipping it with a retarding bellows *B*, which may be adjusted by the air valve *A* on top of the relay.

Another slightly different form of reverse-current relay is shown in Fig. 9. An iron plunger is used and two coils are placed on opposite legs of the iron magnetic circuit. The arrangement is shown diagrammatically in Fig. 13. The iron magnetic circuit *A* and A_1 has a current coil *B* on one leg and a potential coil *C* on the other leg, with a core *D* located between *A* and A_1 arranged to move vertically. With the current flowing in normal direction the magnetism travels up one leg and down the other, as indicated by the arrows. There is no magnetism or at least a very weak field in the core *D* under normal load. Should the current reverse in *B*, then both coils tend to force the flux through the core *D*. When this reversal is sufficient to force enough magnetism through the core, it is lifted up and closes the contacts *E* and *F* by the contact disk *G*, as in Fig. 14, which in turn closes the circuit to a breaker-trip coil.

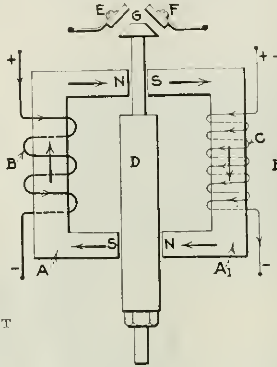


FIG. 13. DIAGRAM OF RELAY FIG. 9 OPEN

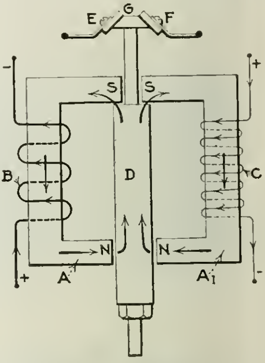


FIG. 14 DIAGRAM OF RELAY FIG. 9 CLOSED

When the current is 1000 amperes or more, the current coil is omitted and a relay like Fig. 10 is used, the cable or bus passing through the insulated hole *H*, the magnetic field set up about the cable being sufficient to operate the relay. If the relay is to be used with a vertical busbar instead of a horizontal one, the parts are slightly rearranged as shown in Fig. 11, but the principle of operation is the same.

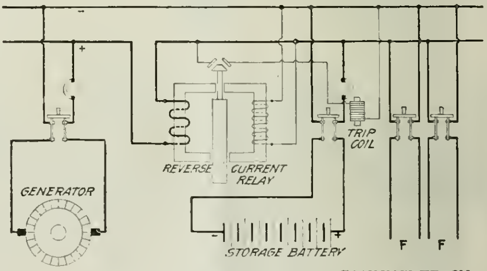


FIG. 15. REVERSE-CURRENT RELAY CONNECTED IN GENERATOR AND BATTERY CIRCUIT

In Fig. 15 is shown a typical case for protecting generators from a reverse current from a storage battery. Under normal conditions the battery is either being charged or it supplies power in parallel with the generator to the feeders *F*. In either case the current will always flow along the positive bus toward the feeders *F*. However, if the generator voltage was to fall below that of the battery and current began to flow from the battery into the generator, the reverse-current relay would act and trip the storage-battery breaker. Of course this condition could be reversed and have the reverse-current relay trip the generator off the line and allow the battery to carry the load. A similar protection is afforded rotary converters against being motorized from a storage battery in case of failure of the alternating-current power source, by placing the trip coil that is energized by the closing of the reverse-current relay on the converter's circuit-breaker. If several machines are operating in parallel and it is desired to protect each machine from reverse-current operation, then a reverse-current relay must be connected in on each machine. Sometimes there is apparatus that must be run without interruption except in case of actual damage to the apparatus itself, and even then the interruption must be confined to the smallest possible areas. To this end spare feeders or lines are often run to each piece of apparatus, and in case of trouble on one line the other is switched on.

If the apparatus is connected in a ring system, and reverse-current and definite-time-limit relays are properly connected into the circuits, the faulty feeder or piece of apparatus may be automatically cut out without interruption to the rest of the system.

If desired, under special conditions, most reverse-current relays may be adjusted to open the breaker when the load merely drops, instead of a full reversal, by making the contacts normally closed and using the current in normal direction to hold them open; the breaker will then trip on either a fall in load or on reverse.

C. E. C. Tube-Scraping Device

In the average boiler plant euipped with forced draft and burning bituminous coal, small sizes of anthracite or coke breeze, it is usual to operate the boilers at considerably above their rated or nominal capacity. High ratings are obtained by high air pressure under the grates, the effect of which is to lift from the grates small particles of incandescent coke and ash, which are carried through the boiler with the furnace gases. Some of this coke or ash adheres to the bottom and sides of the tubes in the bottom row above the fire.

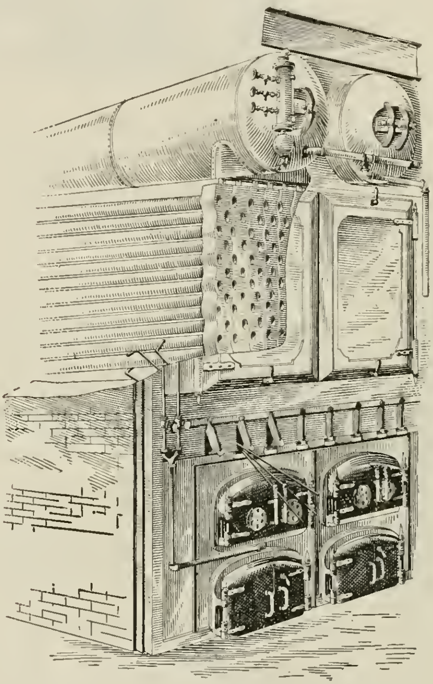
A gradual building up of this cinder continues, closing the opening between the tubes so that the area of the gas passage is in time materially reduced, often so much as to reduce the capacity of the boiler. This cinder can be dislodged by cutting the boiler out of service and then scraping the cinder from the tubes, but this is an expensive operation and would be unnecessary if means were provided to make it possible to scrape the tubes while the boiler is in service.

The usual tube-dusting doors provided in horizontal water-tube boiler settings do not give access to the under side of the bottom row of tubes. To meet this condition the Combustion Engineering Corporation, 11 Broadway, New York City, offers the C. E. C. tube-scraping device consisting of tube-scraping door casting, bottom-tube scraping doors, tube-cleaning or scraping-wall boxes, access doors for tube scraping, as illustrated, the purpose of which is to provide openings in the front or rear wall of a boiler setting through which a light hook may be used for scraping the cinder from the bottom and sides of the lowest row of boiler tubes.

These boxes are made in sections with three, four and five doors which are spaced the same distance apart as the boiler tubes in the boiler in which they are installed. Two or more sections are bolted on angles or Z-bars along the top and bottom sides, providing one opening or door for each space between the tubes. The openings are halfway between tubes so that the sides of the tubes may be reached as well as the bottom, and also the bottom of the second row of tubes.

The castings are of sufficient strength to support the brick wall above them and they will, when placed under the rear header of a horizontal water-tube boiler of the Heine type, support the weight of the boiler also.

The boxes are about 12 in. deep, heavily ribbed vertically between each door or opening. When installed, the brickwork is so laid that the boxes are protected from radiant heat, and being in short sections of 21 to 35 in. in length, will not warp and twist and loosen the brickwork above and below.



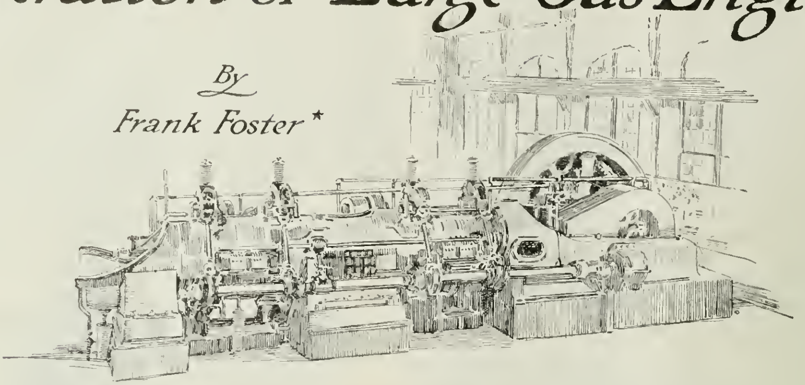
APPLICATION OF TUBE-SCRAPING DEVICE

Each opening is covered by a cast-iron, swinging door or cover, the lower end of which passes behind a tapered spring catch which can be adjusted by a light blow of a hammer to hold the door tightly against the box.

When cleaning the tubes, the attendant takes a rod about ⅝ in. diameter and 10 to 12 ft. long, of the same shape as an ordinary firehook, with one prong about 5 in. long. By striking a projecting lug on the door, the door is swung to one side and the hook pushed into the hole. The two tubes immediately in front of the opening are then scraped with one or two passes of the hook along the sides and bottom, the hook is withdrawn and the door closed by striking the door lug with the hook. In this manner, the lower tubes may be cleaned once a day or as may be required.

Operation of Large Gas Engines

By
Frank Foster*



Practical points with which the operator of large gas engines should be familiar, such as valve timing, ignition timing, over-rating of power and blower engines and remarks regarding care, cleaning and overhauling.

IN WHAT follows reference is made to the large horizontal, four-cycle double-acting gas engine having two gas cylinders in tandem driving onto one crankpin unless the contrary is stated. In the case of blowing engines the air cylinder is behind and in line with the gas cylinders. These engines run at speeds of from 115 r.p.m. for 1000 b.-hp. size to 94 r.p.m. for 2500 b.-hp. size. Larger sizes are at present obtained by employing four cylinders on two cranks.

Valve timing varies with the make of engine, but good practice lies between the following:

Inlet valve opens 20 to 35 degrees before dead-center.

Inlet valve closes 30 to 45 degrees after dead-center.

Exhaust valve opens 35 to 50 degrees before dead-center.

Exhaust valve closes 15 to 25 degrees after dead-center.

The precise values depend on the shape of the cams and on the gas pressure. Eccentrics call for the later openings and earlier closings as a rule. It will be noted that both valves are open together at periods.

Ignition timing should be at about 25 deg. of the crank before the dead-center when starting, advancing to 40 or 45 deg. at full speed; rather less for blowing engines. This timing must be checked by taking indicator diagrams, which should show a nicely rounded peak, neither too sharp nor too flat.

In starting an electric power engine compressed air is the best medium. A pressure of 220 to 250 lb. is suitable, but most engines will start with 150 lb. if sufficient air is available, although it is not advisable to adopt this low pressure, as the air is supplied to two out of the four cylinder ends.

Assume that air is supplied to Nos. 4 and 3 ends, being those of the back cylinder. The order of firing in European designs is usually 4, 3, 2 and 1 from the rear to the front. The procedure then is as follows:

Open the stop valve in the gas main, but not those on the cylinders. If the engine has been stopped for some time, open the pet-cock on the gas pipe for the purpose of clearing air from the gas mains, keeping it open until the flame burns quietly and steadily. Do not open this cock unless it is known that the gas is under pressure.

See that oil pressure is up and that the suction tanks, lubricators and grease cups are full. Then turn on the supply. Next, bar the engine over until the crank is about 30 deg. over the back dead-center, say 8 per cent. of the stroke, the engine being on the power stroke for No. 4, or the rearmost cylinder end. This is indicated by the cam or eccentric being about 50 geometrical degrees (100 deg. of the crank movement) from beginning to open No. 4 exhaust valve. Then put the air-starting cam in gear and force open the automatic air-starting valves on the back cylinder to see that they are free.

Pull out all ignition switches for the four cylinder ends, close the main supply switch on the ignition board and set the ignition distributor to 25 deg. before the dead-center.

Turn on all cooling water and see that all discharges are running freely. Do not admit water into the exhaust pipes until the engine is running. Then open the compressed-air stop-valve and have a man at the gas stop-valve of the front cylinder.

As soon as the engine is fairly moving, usually after the first stroke, close the ignition switches for the ends 1 and 2 (front cylinder) and slightly open the gas stop-valve on the front cylinder—about one or two turns of the handwheel, according to the type of valve and the gas pressure. Every station is a little special in this respect. The engine will not start if the stop-valve is opened too wide; therefore do not open it until the engine is moving. The front cylinder should now fire and the engine gather speed.

As soon as the front cylinder fires, shut the air off the back cylinder, screw down on their seats the air-starting valves on the back cylinder, close the ignition switches of 4 and 3 and open the gas stop-valve on the back cylinder two or three turns. The back cylinder should now fire, and the engine will gather speed until the governor lifts and takes control. Always stand by the ignition board until the governor is in action.

Next, open the stop-valves on the cylinders, adjusting the hand controls if necessary and then advance the ignition to 40 or 45 deg. before the dead-center. The engine can then be put under load. Some adjustment of the hand controls may be necessary, however.

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When starting a blowing engine, first open the air escape or other starting valves on the air cylinder so as to take off all load at starting. Then proceed exactly as for an electric power engine. Where both gas cylinders are fitted for compressed air and it will not start on one cylinder, admit air to both cylinders until the engine turns over. Then shut off the air to the front cylinder and at once admit gas to that cylinder precisely as for an electric engine.

There is usually no governor on this type of engine, and the engine speed must be governed by a handwheel control.

To put load on the engine open the stop-valve in the cold-blast main; open the stop-valve in the air-suction main, if any, and gradually close their air-escape valves on the blowing cylinder.

In running the engine be systematic. Clean and inspect periodically to program and keep the engine, house, basement and auxiliaries clean. Also watch the gas and water for cleanliness and temperature. The gas temperature should not exceed 70 deg. F. except in summer, when it can rarely be much below atmospheric. It should contain not more than 0.01 gram of dust and tar per cubic meter (about 0.005 grain per cubic foot) and no suspended moisture. Dry gas is as important as clean gas.

The water temperature should not exceed about 70 deg. F. at the inlet to the engine, but here again atmospheric conditions in summer may lift it. Provided sufficient water is available, no harm will result. The water must be free from acids and suspended matter and should be soft.

Outlet-water temperatures should, in general, be kept below 120 deg. F., but it may be necessary to use higher temperatures, particularly for the pistons and exhaust-valve boxes. A limit of 150 deg. F. is desirable. Remember that there are local hot points which throw down scale at quite moderate water-outlet temperatures.

Keep the water flowing in reduced quantity after stopping the engine until the outlet is cold. Shut off the piston water last. Otherwise the heat stored in the engine will throw down scale in the stagnant jacket water. Piston water should be under a pressure of 50 lb. per sq.in. For blowers 40 lb. is sufficient on account of the lower speed. The water flow should be adjusted for variations of load, but not for rapid fluctuations. Take check temperatures as may be necessary. Water for the exhaust pipes (injection) should be admitted after getting the engine running and shut off before actually stopping. Hard and salty waters are objectionable for exhaust cooling and silencing.

If the gas is richer than the average, less gas and more air are required. Adjust the hand controls accordingly.

Preignitions may be due to overloading the engine. Explosions in the exhaust are frequently due to a bad mixture, usually too weak a mixture. Adjust the hand controls to suit.

The main bearings, slides and connecting-rod lubrication is generally fed from a common service. About 20 lb. pressure is usual. Too much oil in the cylinders, stuffing-boxes and exhaust-valve spindles leads to carbonaceous deposits and must be avoided. On the other hand, insufficient or unsuitable oil cannot be tolerated. A good oil gave the following results:

Flashpoint, open test, deg. F.		450
Acidity as H_2SO_4, under, per cent		0.015
Loss by heating 6 hours	at 212 deg. F.	*nil*
	at 370 deg. F. under, per cent	3.0
Fatty oils, per cent		*nil*
Resinous oils, per cent		*nil*
Absolute viscosity at 100 deg. F., per cent		0.70
Absolute viscosity at 200 deg. F., per cent		0.115

In Europe it is usual to use one oil throughout the engine, in which case an oxidizing, or sludging, test is important. The consumption in 24 hours for an electric engine should be about 8 Imperial (9.5 U. S.) gallons per 1000 kw. rating. For a blowing engine about 4.5 Imperial (3.75 U. S.) gallons per 1000 brake-horsepower blower rating, in 24 hours.

Hot piston rods are usually local and generally due to dirt in the stuffing-boxes. If possible take the load off the hot cylinder end, and in any case reduce it. Whenever possible slow the engine down but do not stop. If very hot, syringe the rod with oil. Putting a slug of kerosene through the box by means of the force-feed lubricator sometimes acts beneficially, but often it dislodges more carbonaceous deposit—if the box is in a dirty condition—and leads to other troubles.

For indicating use a heavy mainspring (about 200 lb. to the inch) and a light spring (about 10 lb. to the inch) and take indicator diagrams once a week. A diagram taken with the former spring gives general information and also the nature of the ignition. A nicely rounded explosion peak should be aimed at. If the ignition is too early, the peak will be very sharp. This slightly improves the economy, but increases the wear and tear on the engine. The engine will pound on turning the centers if the ignition is too early.

The light-spring diagram indicates the action of the valve timing, which is usually permanent, and also the influence of the hand controls, which sometimes get badly set. The desirable features are as follows: The reversals of the pencil line should be blunt rather than sharp at both ends; the suction and compression lines should cross the atmospheric line near their respective ends; and the pressure of the exhaust above atmosphere and of the suction below atmosphere should be small.

The engine expands to the rear when working, and this sometimes causes the brushes to short-circuit the rings of the ignition distributor. Adjustment of the distributor in relation to the brushes puts the trouble right.

Dirty or wet gas, or excessive or unsuitable oil, will make the engine dirty and lead to preignitions. If these occur at normal loads, the engine requires laying off for cleaning.

Leakage of gas past the joints between the cylinder and the covers, valve boxes or ignition plugs is dangerous. It is most likely to occur at the exhaust-valve seat. The engine should be stopped and the joint remade.

Leakage of gas from the stuffing-boxes must not be allowed to go too far, but a wisp of gas is not immediately dangerous. Blowing past the exhaust-valve spindle is noisy but not vital and can wait a moderate time for attention.

Test the CO_2 in the exhaust gases once a week to check the combustion and efficiency of working.

Cleaning and overhauling should not be overlooked, as much depends upon conditions, but the following is a useful guide: A general overhaul should be made every six months. The time may be increased to nine or twelve months if experience shows this to be safe.

Wash out the cylinder and cover the jackets every two months, more or less as experience dictates. Clean the stuffing-boxes every six weeks to six months according to the type of box, class of oil, cleanliness of gas and as experience dictates. Remove and attend to the ignition plugs every six weeks to three months as experience shows desirable. Remove and clean water-cooled exhaust-valve seats every two to six months as found necessary.

When getting the engine ready for service, pay particular attention to the following points: All cylinder joints to be thoroughly first-class; all joints, sliding or fixed, on the piston water service to be first-class; piston-rod coupling to be screwed up hard; cylinder covers to be screwed up hard and the oil filters cleaned frequently.

Changed Ammonia-Condenser Piping

By W. T. Meinzer

I was operating a 10-ton absorption ice machine having submerged condensers, and the amount of city water that went to waste caused considerable worry, therefore plans were laid to save it. The piping as originally laid out provided a cold-water connection to each tank, the overflow going to the sewer. The piping shown in Fig. 1 indicates the changed layout, which was arranged to make the flow of water counter-current to the flow of heat in the ice machine as far as possible.

The problem of getting the water out of the second condenser tank and through the absorber into the upper tanks was at first a hard one to solve, but it was eventually done by installing a water-operated ejector in such a manner that the water was taken from near the top of the tank and forced through the apparatus by the pressure in the street piping. Water for the second condenser was supplied by a separate pipe carried to the bottom of the tank, which was removed by the ejector. The speed of the pump was controlled by the height of water in the first weak-liquor cooler. To do this a diaphragm valve was placed in the steam-supply pipe to the pump and a ball-operated valve was placed in the weak-liquor cooler. The ball valve was installed upside down so that the valve opened when the water rose and closed when it fell. A $\frac{3}{8}$-in. pipe connected the diaphragm chamber of the steam-pump valve and the ball valve. Connected to this was a $\frac{3}{8}$-in. pipe from the street water-pressure supply pipe having in it a valve to regulate the amount of opening. With the water low in the weak-aqua tank the ball valve would be closed, and water pressure admitted to this pipe would close the diaphragm valve, stopping the pump. When water rose in the tank the ball-cock would open, relieving the pressure, the diaphragm valve would open and the pump would start. The leakage into the pipe was regulated by the valve. The water wasted from the ball valve ran into the tank and was pumped with the other water into the house.

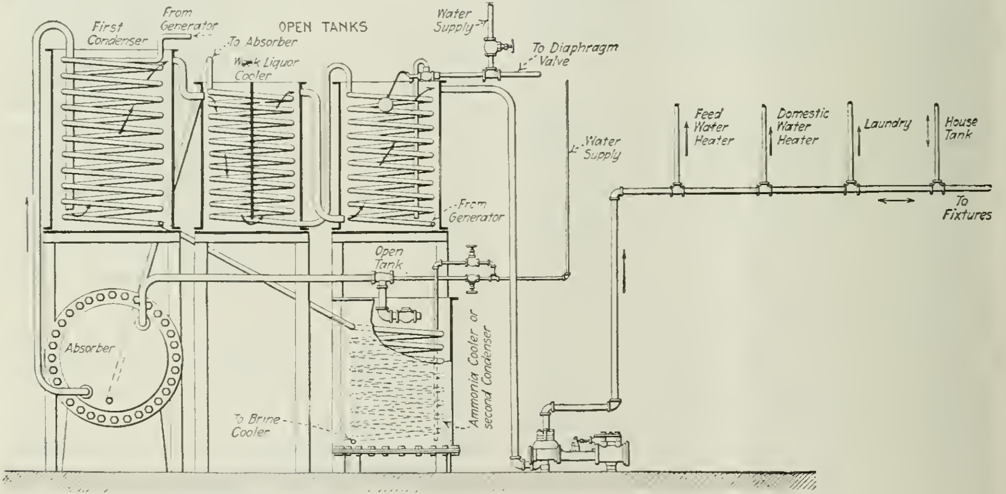


FIG. 1. PIPING SHOWING CHANGED LAYOUT OF THE CONDENSER SYSTEM

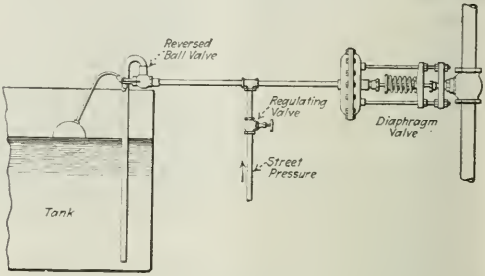


FIG. 2. BALL VALVE AND DIAPHRAGM VALVE CONNECTIONS

When this system was put in operation, it was found that nearly enough water was used on the ice machine to supply the building for other purposes, and as we did not then have to save on the water for the ice machine we were able to use more of it and get lower head pressure on the ammonia, with a consequent saving of steam to operate the pumps and generator. The slightly warmed water was welcome in the laundry and saved steam there and in the hot-water tanks where steam, either live or exhaust, is used to heat it any way. The drinking-water system is an independent one and is supplied by a separate pump so that the slightly warmed water did not cause any complaint. As a result of the chill being taken off the water, the piping did not "sweat" in the bathrooms, etc.

It was found that these tanks as piped acted as water purifiers, as all of them collected large quantities of mud, which had to be washed out through valves placed in the bottoms for this purpose. The slight heating of the water and the slow movement of it through the tank facilitated this action. Of course this meant less scale in the boilers and piping. Makeup water necessary to keep the house tanks full was supplied by another pump, regulated by a governor connected to the house-tank supply pipe.

One night one of the engineers purged the absorber, by sticking the hose from the purge valve into the condenser tank. The next day the chef complained that there appeared to be an ammonia leak in the kitchen somewhere near his range. I investigated and found that the ammonia odor came from the pot that he was using for cooking, and I immediatey started to test my condensers, etc., for leaks. When discussing the trouble with the night-engineer, the mystery was solved and he was requested to purge into a pail thereafter.

The housekeeper used large quantities of aqua ammonia for various cleaning purposes and sometimes would come to me for a little when his supply ran out. One day I secured a large water bottle and filling it with water arranged it so that when purging the absorber we would purge into this bottle. Escaping gas would be absorbed by the water, and when it became charged to about 10 deg. Baumé I would turn it over to the housekeeper and set a fresh bottle of water in its place. The house was saved the expense for this cleaning supply, and the engineer's department did not lose anything by it, as otherwise it would have been thrown into the sewer.

Pneumatic Ash Conveying

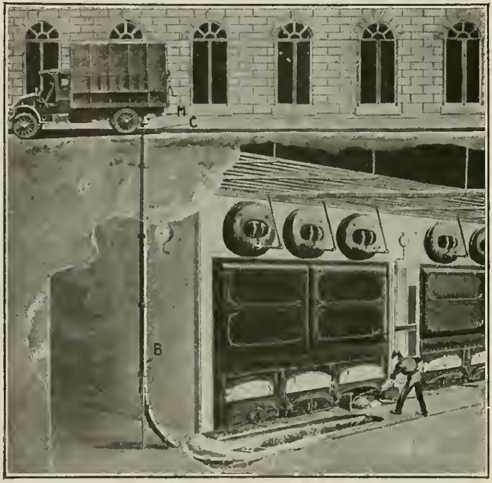
Disposal of boiler-room ashes in the city is, in most instances, an annoyance and generally necessitates the installation of some kind of an ash-conveying system if the slow and tedious method of using ash cans is not used. Generally an ash bin has to be built in which to stow the ashes until they can be removed by trucks. If ash cans are used, there is the labor and city ordinances with which to contend and comply.

The disposal of ashes from the city plants seems to have been solved by the Ash Removals, Inc., 347 Madison Ave., New York City, who have a system that comprises the installation of a conveying pipe in front of the boilers to a point at the sidewalk where a connection is made to a motor-driven ash truck. The system as installed is illustrated herewith

A 3 x 3 ft. concrete pit is built in front of the boilers and is provided with sectional sheet-iron covers making it possible to uncover any section at will. An 8-in. conveying line *B* extends from beneath the concrete pit and terminates under the sidewalk at the curb. At convenient points in the pit ash intakes are inserted in the conveyor line. These intakes extend to the pit and are flush with the bottom of it.

The conveyor truck consists essentially of a 6-ton chassis equipped with a high-pressure blower driven by the truck motor, a washing device for eliminating dust from the air before exhausting into the atmosphere, a silencer and a steel bin or separator that is placed above the machinery and forms the body of the truck. The conveyor truck connects with the terminus of the conveyor line *B* at the curb by means of an extension pipe *M*, hung on a rocker joint, which allows ample flexibility for alignment in making the connection.

The system operates as follows: Ashes are raked from the boiler ashpit into the concrete pit. Upon the arrival of the conveyor truck, the operator makes the necessary connections to the conveyor line and starts the blower, etc., on the conveyor truck. An assistant enters the boiler room for the purpose of feeding the line with ashes. When all ashes have been removed, the conveyor truck is disconnected from the conveyor pipe, and the ashes are discharged from the bin of the conveyor truck into a dump truck by gravity, through gates. The dump truck then proceeds to the point of disposal, and the conveyor truck proceeds to the next building to repeat the process.



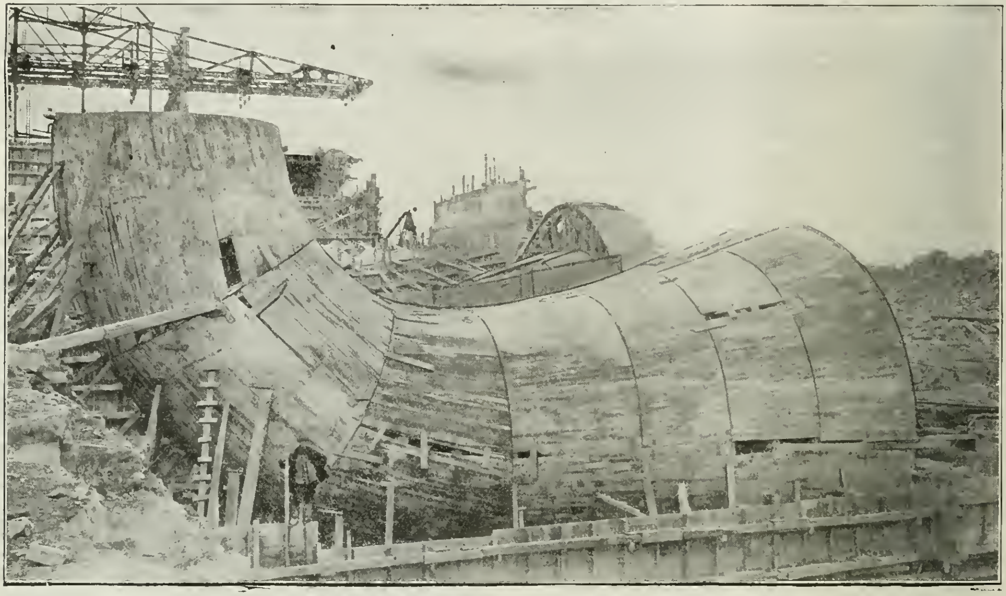
CONVEYOR TRUCK CONNECTED TO ASH-CONVEYOR LINE

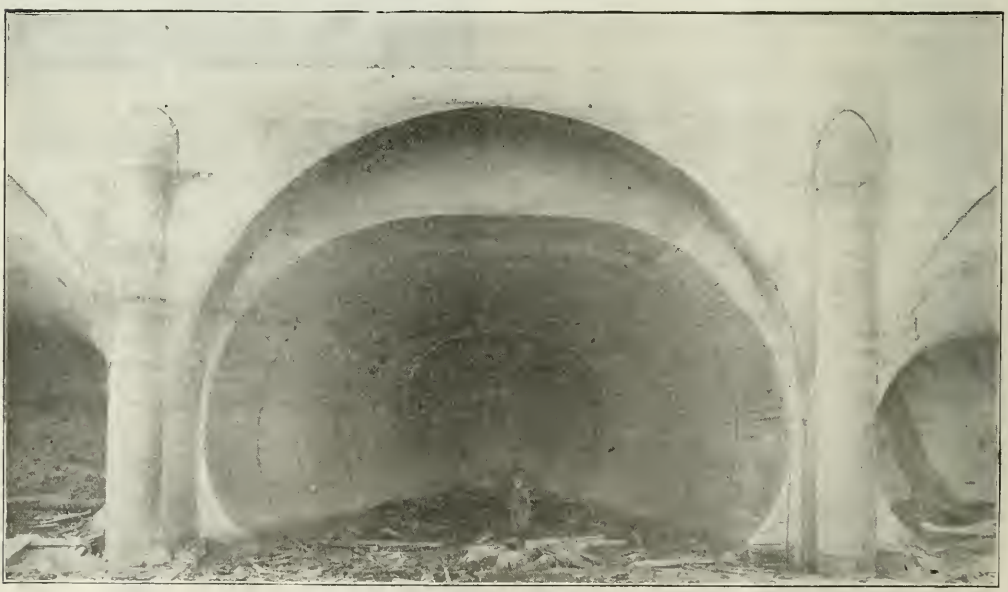
The system is installed under the following conditions: The conveyor line from the ashpit, bin or ash pile in the boiler room to a point under the sidewalk is sold to the plant owner, and for a stipulated sum per annum for a period of ten years the line is maintained against the sulphuric-acid decomposition and the abrasive action of the ashes. The Ash Removals company owns and operates the conveyor trucks and sells this service at a fixed rate per cubic yard of ashes removed, based on the percentage of ashes resulting from a given quantity of coal consumed.

Fear of foreign competition is leading many business firms to overcome their previous dislike for one another and to combine under the Webb-Pomerene Law; while the action of many Government agencies in eliminating competition during the war to facilitate greater production has forcibly impressed all business men with the benefits to be obtained from the mutual interchange of ideas.

Draft Tubes at the Cedar Rapids Plant

THOUGH built some years ago, the draft tubes of this great hydro-electric station, views of which are shown herewith, are interesting, particularly because of the more broad recognition of the possibilities of water power, interconnection of electric systems, etc. The top view on this page shows the wooden forms for the concrete tubes. Their huge proportions are better appreciated by comparison with the man in the left foreground. The picture below is rather unusual and shows the finished tubes viewed from their outlet ends. Notice the man standing in the center foreground.


WOODEN FORMS FOR THE CONCRETE DRAFT TUBES


OUTLET END OF THE FINISHED DRAFT TUBES

Some Hints on Turbine Operation

By H. E. BRELSFORD

The following aims merely to give operators a few hints on some of the important phases of steam-turbine operation.

A TURBINE is a simple piece of apparatus, yet it requires careful attention or there will be large losses attendant upon its operation. The interstage leakage is equivalent in its action and results to a leaky engine piston that lets steam pass through from one end to another or the valve that lets high-pressure steam escape by it directly into the exhaust space and thus do no useful work. This loss on small turbines may easily reach to 25 and 30 per cent. and even on large turbines to as high as 15 and 20 per cent.

Frequently, turbines will run continuously for periods of one, two or three years with no inspection other than of governors or bearings. Then, when dismantled, it is found that there have been serious leaks between stages or through bypasses.

Another large source of loss is in low vacuum, due either to such continuous running as noted above, which makes it impossible to clean the condenser, or to neglect to keep the vacuum pump in proper operating condition. In the region of 26 to 29 in. vacuum the average loss in efficiency is 6 per cent. per inch loss of vacuum. This low vacuum may be due to less than normal speed of the circulating pump or neglect to keep the glands properly sealed, which also cuts down the quantity of water being circulated.

Loss from Excessive Back Pressure on Exhaust

If it is a noncondensing turbine, a considerable loss may result from excessive back pressure on the exhaust due to careless adjustments of the pressure regulator on the feed-water heater or poor vacuum (or no vacuum) on the heater system if the steam goes into such. The loss is from 1½ to 2 per cent. for each pound of back pressure above atmosphere. It reaches a considerable value if the pressure varies from 5 to 50 lb. as it did in one plant recently investigated. Aside from the decrease of efficiency it curtails the power of the turbine.

In spite of the well-known results of superheated steam on turbine performance, it is still the exception to find industrial plants with boilers equipped with superheaters. From wet to extremely wet steam, is the rule, and some installations should have a waterwheel maker's name-plate on them to indicate the actual conditions of operation. Such wet steam results not only in a loss of economy but in a rapid increase of bucket erosion and reduction in efficiency from loss of proper bucket contours. All steam turbines are subject more or less to deterioration under conditions of wet steam. High steam velocities relative to bucket velocity aggravate this condition.

Many of the so-called steam separators on the market are of no use whatever, as the quality of steam on the turbine side of the separator is but little better than on the boiler side. Manufacturers seem to have lost sight of the fact that steam velocities in pipe lines have gone to such high values that there cannot be the same degree of separation as with low velocities. Most separators are much too small in volume and length to be effective.

Turbines are sometimes installed with the exhaust piping rising from the turbine and no drainage or inadequate drainage provided. The writer has known of cases where the last one or two wheels of a turbine were constantly rotating with part of their periphery submerged in water that remained in the exhaust piping and backed up into the turbine casing. The loss of power in rotating even a thin disk at high speed with only a fraction of an inch of its rim contact with water is great. The water not only absorbs large amounts of power, but rapidly spoils the turbine buckets and in most cases will eventually loosen the turbine disks on the shaft. This destroys both the disk and the shaft as a rule and means, of course, shutdown, expense for repair parts and for installing them. See that a liberal-sized drain has a properly operating trap attached or other means of getting rid of all the water.

Testing the Vacuum Breaker

A condition productive of accidents is often encountered where turbines are connected to jet condensers by short pipes. Most such condensers are equipped with proper vacuum breakers that prevent flooding of the turbine if the condenser pump stops. There is always the possibility of such vacuum breakers sticking and they should be tested occasionally. Do not test them when the main unit is running or even warm. Build up a vacuum with the main unit stopped, then suddenly shut down the condenser removal pump and notice whether the water goes into the turbine. If the vacuum breaker operates properly, it will prevent this. On several occasions the writer has seen large turbines stopped almost instantly from full speed by the condenser flooding the turbine. Such an event puts enormous strains on the turbine rotor, and in two cases it twisted off the turbine shaft and partly wrecked the turbine. Beside this it puts temperature stresses in the turbine casing and may make the rotor rub hard before coming to a stop.

Be Prepared for Trouble

If one of the wheels or disks came loose or was wrecked during operation, would you know what to do to remove the disk or buckets and put the turbine back into service? Would you know that the turbine could run under such conditions and that such operation could be continued until repairs were obtained? Would you know how much the power was decreased by eliminating one or more wheels? Would you know how to bring the power up to normal temporarily by installing a bypass in an intermediate stage? Would you know how much more steam would be required to get this additional power so you could determine what size bypass to use? If you installed such a bypass, would you know what connections to make so that the governor would control it and thus prevent overspeeding if the load dropped off?

All these things can be determined, and even if one does not know about them, one should make plans to obtain such information or to at least know how to find it quickly. One can always resort to the expedient of wiring the manufacturer for an expert to come out and solve the problem. At times, however, one may have difficulty in getting help, as such services are not always available.

One of the first things a person thinks of when looking at a turbine is oil, simply because it is realized that lubrication must be nearly perfect to enable shafting to rotate at such speeds and with such smoothness. Oil may be likened to a suit of clothes. A cheap suit covers one as well as an expensive suit, yet not for the same length of time nor is it so strong for the same weight. It does not protect one so well from the elements. The same things are true of an oil. A cheap, poor-grade oil will not stand up to service so long as a good oil because it actually wears out. Neither is it uniform, and therefore it does not protect the bearing surfaces. The oil may be running all right at one time, and soon the bearings may be heating. Furthermore, the poor oil will not resist outside forces such as the influence of water or extreme heat any more than will the cheap suit. Such elements result in a rapid breaking up of the oil and its total destruction as a lubricating medium. Naturally the fundamental requisite for an oil is that it must *lubricate;* and lubricate is a large word.

KEEP RECORD OF OIL TEMPERATURES

A good turbine oil should maintain its lubricating qualities at 150 deg. F., and give a good average life. If oil is too thin at this temperature, the bearing surfaces will wear and the tendency will be for the oil temperatures to rise and the structure of the oil to break up. An oiling system should reach a condition of equilibrium after about two hours' run. Keep a daily log of oil and cooling-water temperature, the oil temperature being kept for each separate bearing. Plot a chart of water and oil temperature for each bearing. If there is a steady tendency for these temperatures to rise from the start, it is quite certain that the bearings are not receiving a sufficient supply of oil, are not fitted properly or that the oil is breaking down. Assuming that mechanical conditions are proper, the oil is to be looked to as the cause of the trouble.

When the oiling system is charged with fresh oil take out a four-ounce sample and keep this corked in a bottle, properly labeled. After a week's run take another sample. Allow it to set for several hours and compare it with the original fresh sample. You will at once notice the presence of any sediment, water or discoloration. Each week take out a sample, label it and compare with previous ones. This gives a visible record of the condition of the oil and in connection with the temperature charts will enable you to keep close tab on lubricating conditions. If the samples show presence of water, it is most important that its source be located and stopped, as water is an active agent of destruction to oils and their lubricating value.

WHY LUBRICATING OIL DISCOLORS

Oil may rapidly discolor. If the surroundings and oiling system are such as to introduce much dust, they will discolor the oil. Water containing chemicals will do the same. Oil containing paraffin and mixed with water will discolor. An oil improperly refined, one mixed with other substances to give it body, or mixed with nonmineral oils will quickly color, and a difference in structure can be noticed almost hourly. Such oils are dangerous and should be avoided.

If you desire to experiment with oils or are intending to use an oil not approved by the turbine manufacturers, then you should accurately test each oil by actual operation in connection with close observation and records.

The Electrical Study Course—Generation of Alternating Voltages

Explains how an alternating voltage is generated in an electric machine, and shows what the value of the voltage will be at different positions of the armature.

IN the preceding lesson the curve of an alternating voltage as generated by a single conductor cutting a uniform field was constructed. In the present lesson we shall plot a similar curve from a generator whose field is uniform and the lines of force in which are assumed to be parallel to one another, as indicated in Fig. 1. The armature has two taps, *a* and *b*, diametrically opposite each other, and is supposed to revolve in a counterclockwise direction as indicated by the curved arrow. At the instant the taps pass the mid-point of the polepieces, which is the position indicated in the figure, the voltage between them will be zero, since the conductors between *a* and *d* will generate a voltage opposite to that generated by those between *d* and *b*, while the voltage generated by the conductors *a* to *c* will oppose and neutralize that due to the conductors between *c* and *b*, as may be seen from the arrowheads on the windings. The turns that pass through the positions *c* and *d* have no voltage generated in them, since they cut no lines of force, and are therefore left blank.

When the armature turns 90 deg., the tap will pass through *c* and *d*, as in Fig. 2. At this instant the voltage across the tap will reach its maximum value as all the conductors between *a* and *b* will be generating voltages in the same direction. When the armature passes through the second 90-deg. position, as in Fig. 3, the taps *a* and *b* are again at the middle of the polepieces, but they have interchanged positions, and as in Fig. 1 the voltage is again zero. When passing through the third 90-deg. position—that is, when the armature has revolved 270 deg., as in Fig. 4—the condition will be the same as for 90 deg., Fig. 2, except that the taps are interchanged, causing their polarity to be reversed. After an entire revolution the cycle of changes would be complete, and it is evident that an alternating voltage has been generated across taps *a* and *b*, increasing from zero in Fig. 1 to a maximum value in Fig. 2, decreasing to zero in Fig. 3, then reversing and increasing to a maximum value again in Fig. 4, after which it decreases to zero as the revolution is completed and the armature comes into the position shown in Fig. 1.

Knowing the value of the voltages for 0, 90, 180, 270 and 360 degrees position, we can begin to construct a curve representing the alternating voltage generated. At 90 degrees we have passed through a quarter turn, or one-quarter cycle, at 180 degrees through a half turn, or one-half cycle; similarly at 270 and 360 degrees we have passed through three-quarters of a cycle and one cycle respectively. The points for the curve that we can plot will therefore be those indicated in Fig. 5 for *h*, *d*, *k*, *c* and *h*. Before the shape of the curve passing through these points can be determined, points for positions of the armature other than those so far investigated must be found.

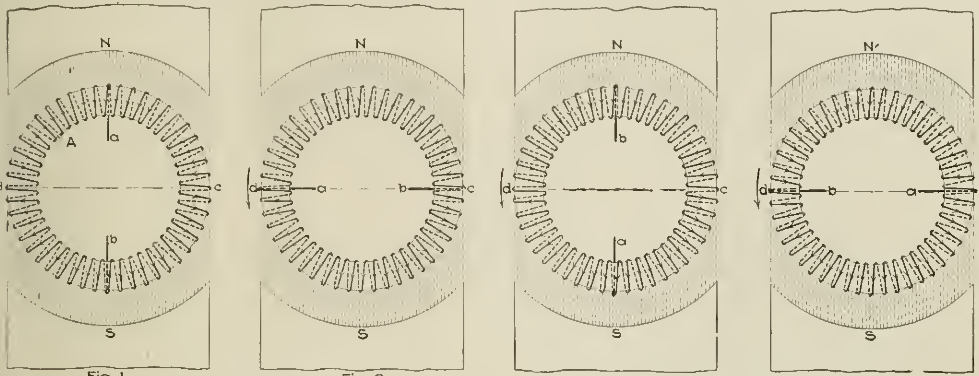


Fig. 1 Fig. 2 Fig. 3 Fig. 4

FIGS. 1 TO 4. ARMATURE IN DIFFERENT NINETY-DEGREE POSITIONS OF A REVOLUTION

From the fundamental theory of the generation of voltage we know that the voltage developed is directly proportional to the rate at which magnetic lines of force are cut across. From Fig. 7 it will be seen that when conductor 1 moves from *A* to *B*, it will cut all the lines of force between I and II; also when 2 passes from *B* to *C* it will cut the lines between II and III. We can trace the movement of each of the conductors in this manner until we finally get to conductor 12, which in passing from *N* to *P* will cut the lines of force between XII and XIII. Since the number of lines cut in passing from one position to another is what determines the voltage generated in the conductor cutting them, it follows that the distance between lines I and II, II and III, etc., is a measure of the voltage generated in a conductor as it moves from one to another of the positions. If the distance from I to II is laid off equal to 1, careful measurement will determine the other distances to be those given in Table I.

TABLE I. DISTANCES BETWEEN REFERENCE LINES IN FIG. 7

I to II	1.000	V to VI	0.833	IX to X	0.443
II to III	0.983	VI to VII	0.753	X to XI	0.322
III to IV	0.949	VII to VIII	0.661	XI to XII	0.196
IV to V	0.899	VIII to IX	0.557	XII to XIII	0.065

Suppose, in Fig. 7, that in passing from *A* to *B* conductor 1 generates 10 volts; then it is evident that 10 volts is generated for every like distance of field cut across. Since in passing from *A* to *B* the conductor moves from 1 to 2, a distance assumed to be equal to 1, then if we multiply the distance between the reference lines II and III, III and IV, etc., as given in Table I, by 10 volts we will get the value of the voltage generated in each case. Making these multiplications for all the distances given in Table I, we obtain the values of voltages appearing in Table II.

TABLE II. VALUE OF VOLTAGES GENERATED BY CONDUCTORS IN FIG 7.

	Volts		Volts		Volts
I to II	10.00	V to VI	8.33	IX to X	4.43
II to III	9.83	VI to VII	7.53	X to XI	3.22
III to IV	9.49	VII to VIII	6.61	XI to XII	1.96
IV to V	8.99	VIII to IX	5.57	XII to XIII	0.65

Referring to Fig. 8, which is the same as Fig. 1, except that the armature has turned 30 deg. in the direction of the curved arrow, it is evident that the voltages generated in sections *pd* and *dl* of the winding are equal and opposite, therefore neutralize each other; a similar statement may be made regarding the voltages generated in sections *mc* and *cn*. This will leave sections *pm* and *ln* effective in developing an electromotive force across taps *ab*. The voltage between *pm* is twice that between *hp*. Referring to Fig. 7 the pressure between *h* and *p* is found to be that between I and V. Taking the values from Table II, we have 10+9.83+9.49+8.99 =38.31 volts. Since the volts between *p* and *m* or *l* and *n*, Fig. 8, equals twice that between *hp*, it equals

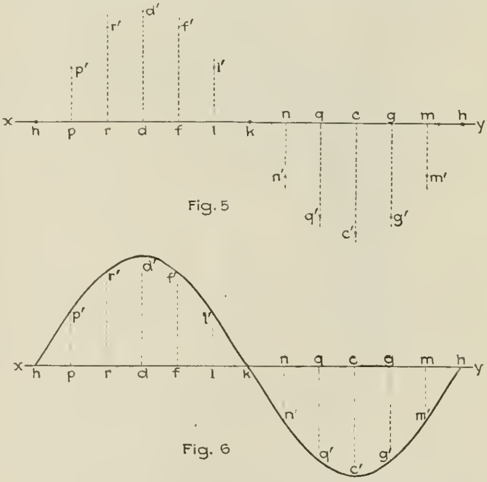


Fig. 5

Fig. 6

FIGS. 5 AND 6. ALTERNATING-VOLTAGE CURVE

38.31×2 or 76.62; that is, the volts across taps *ab*, Fig. 8, equal 76.62.

In Fig. 9 the armature has revolved 30 deg. from the position in Fig. 8. In this position it is evident that the voltages generated in sections *rd* and *df* are equal and opposite, consequently neutralize each other, likewise for section *gc* and *cq*. This leaves sections *gr* and *fq* effective in producing an electromotive force across taps *ab*. The voltage generated in sections *gr* and *fq* is equal to twice that generated in *hr*, which from Fig. 7 is found to be equal to that between I and IX. Taking the sum of the values given in Table II for this section it totals up 66.35. Hence, the voltage between *r* and *g*, and *f* and *q*, Fig. 9, equals 66.35×2=132.7.

In Table II we have all the voltages in one-quarter of the armature so that by taking their sum and multiplying by 2 we can determine the value of the maximum voltage, or that developed across tap *a* and *b* in Fig. 2 and Fig. 4. Doing so, we find the sum to be 76.66 volts, which multiplied by 2 gives 76.61 × 2 = 153.22 volts as the maximum voltage. We are now in a position to determine the location of the intermediate points of the curve. If we let the vertical distances *dd′* and *cc′*, Fig. 5, represent the maximum voltage, or 153.22, all that will be necessary will be to lay off on the verticals erected at *r* and *p* distances *rr′* and *pp′* to scale equal to 132.7 and 76.62 respectively, the voltage generated in the armature when in the position Figs. 8 and 9, to locate intermediate points on the curve. By connecting these points, a curve representing the voltage on the first quarter of a cycle will be determined. On the next quarter of a cycle the voltage will pass through the same series of values but in the reverse order; that is, decrease from a maximum to zero. Therefore, by applying the foregoing methods to the other three quarters of the cycle, intermediate points *f′ l′ n′*, etc., will be determined, and by joining these points a curve, Fig. 6, representing the instantaneous voltage throughout the cycle, will be obtained. This curve, it will be observed, is identical in shape with the curve obtained when only one conductor was used in the previous lesson.

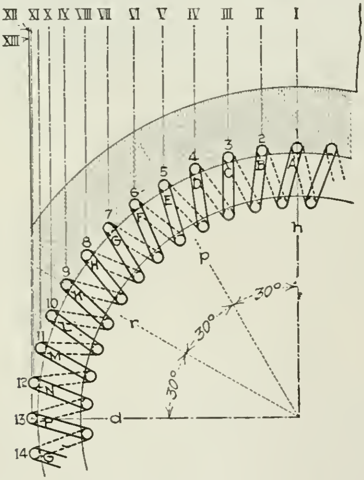


FIG. 7. ENLARGED SECTION OF THE ARMATURE SHOWN IN FIGS. 8 AND 9

In the last lesson the problem given was to find the pull at full load in a 9.5-in. belt when connecting a 25-hp. motor, running 825 r.p.m., to its load. The motors pulley was assumed to be 10 in. in diameter. Since 1 hp. equals 33,000 foot-pound-minute, the motor at full load will develop 33,000 × 25 = 825,000 foot-pound-minutes. The speed of the belt in feet, assuming zero slip and neglecting the thickness of the belt, is equal to the peripheral speed of the pulley, or this equals $\frac{\pi D S}{12}$, where *D* equals the diameter of the pulley in inches and *S* the revolutions per minute; hence the

$$\text{peripheral speed} = \frac{3.1416 \times 10 \times 825}{12} = 2160 \text{ ft.}$$

per min. Foot-pounds per minute = pounds pull × the distance in feet per minute, from which *pounds full = foot-pounds per minute ÷ by distance in feet per minute,* in this problem equals 825,000 ÷ 2160 = 382 lb. The motor was assumed to be operating on a 230-volt circuit and taking 95 amperes a full load. Then the *input in hp. = volts × amperes* ÷ 746 = 230 × 95 ÷ 746 = 29.3. Per cent. efficiency = $\frac{\text{Output} \times 100}{\text{Input}} = \frac{25 \times 100}{29.3}$ = 85.3 per cent.

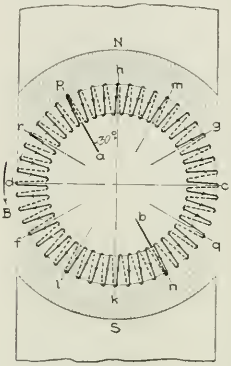


FIG. 8. ARMATURE TURNED 30 DEG. OFF ZERO POSITION

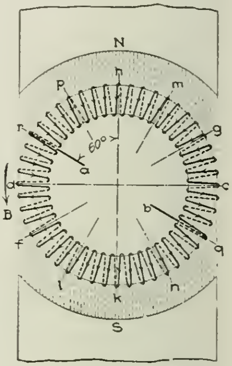


FIG. 9. ARMATURE TURNED 60 DEG. OFF ZERO POSITION

A motor is used to drive a generator; when the generator delivers 225 amperes at 117 volts, the motor current is 73 amperes at 550 volts. The efficiency curve of the motor is furnished and at the load mentioned the efficiency is found to be 82 per cent. Find the efficiency of the generator.

A cylinder that leaks because of open-grained or porous iron can be made steam-tight in the following manner: Make a saturated solution of hydrochloric acid (also known as muriatic acid) and iron drillings; pour this solution into the cylinder or wash the interior of the cylinder with it; then apply ammonia water and a pressure of steam or air. When dry, the cylinder will be steam-tight. The hydrochloric acid solution is made like soldering acid except that iron drillings are used instead of zinc.—*The Combustion Chamber.*

New Heating and Ventilating System for Chicago Schools

By JOHN HOWATT
Chief Engineer, Bureau of School Engineering, Chicago

THE accompanying diagrammatic layout shows the heating and ventilating system designed by the Bureau of School Engineering, Board of Education, Chicago, and now installed and in working condition in the Rezin Orr and the Laughlin Falconer schools. The general design appears so satisfactory that arrangements are being made to use it in connection with the construction of other school buildings.

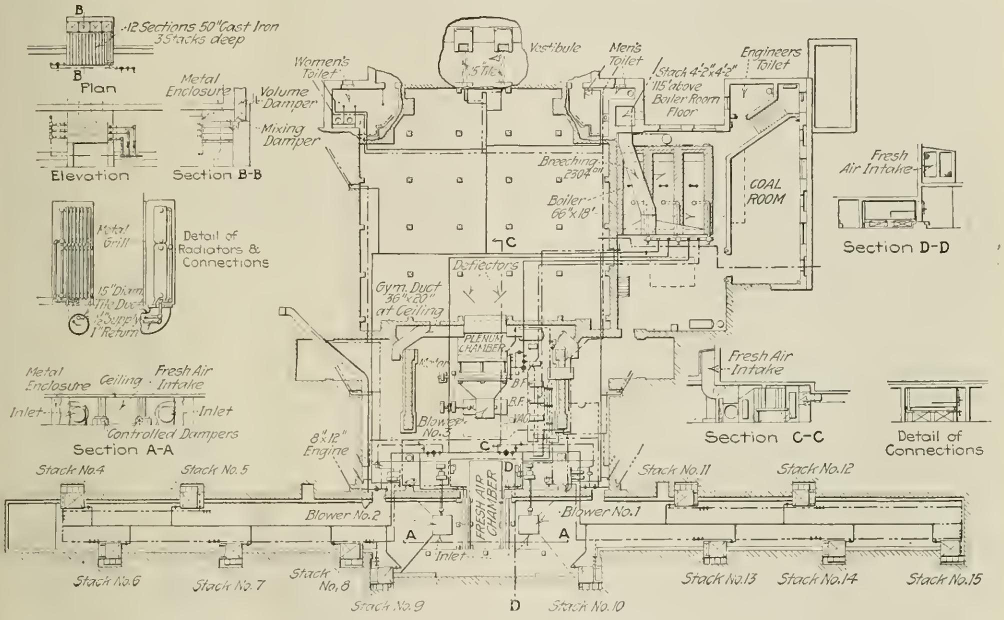


DIAGRAM OF PIPING LAYOUT IN THE SCHOOL

Standard heating and ventilating equipment as installed in the Chicago public schools for the last twenty years, has been subjected frequently to the following criticisms:

1. The layout called for the installation of long horizontal ducts, which provide ideal places for the settlement of dust so prevalent in Chicago air, from which the dust cannot be dislodged.
2. The plenum-chamber system of ventilation is seriously affected by the opening of the classroom windows, the design being such that the opening of one or two windows will seriously affect the air distribution throughout the entire system.
3. The difficulty in heating and ventilating only a part of the building when desired.
4. The high cost of galvanized sheet-iron work during the last two years.

These complaints were quite general, and it was in an effort to overcome them and provide an improved and more flexible heating and ventilating scheme that the arrangement for the Orr and Falconer schools was developed. This general idea is not original, but is new in Chicago public schools and has some features that may be of interest.

In the new plan fresh air is taken through a shaft leading to the outside atmosphere at the roof line by means of power-driven fans, is drawn through tempering coils, or radiators, which temper the air to 70 deg., and is then blown into a large tempered-air plenum chamber consisting of an excavated space beneath the corridor on the first floor. This excavated space is obtained by removing the earth between the corridor wall foundations down to a point eight feet below the first floor line, then placing a cement floor on the bottom, thereby providing a tunnel or chamber the length of the corridor and fourteen feet wide, or the width of the corridor and eight feet high.

Reheating coils are set below each tier of classrooms in recessed spaces constructed of concrete along each side of the tunnel. From these recesses, if the building is three stories high, three hot-air supply ducts are carried, one to a classroom on each floor. These ducts are provided with automatic mixing damper arrangements whereby the air will be taken either from the reheated air space above the reheating coils, or bypassed around the reheating coils so as to take only the tempered air in the tunnel.

In districts where the conditions warrant, an air washer may be placed in front of each blower, and some air cleaning and air moistening effect may be obtained readily by having a finely perforated water pipe placed across each tunnel near the blower end. Each of these tunnels is provided with water piping and hose connections so that the walls and floors can be washed out daily, the floor being pitched to a suitable drain.

The boiler equipment consists of three 66-in. x 18-ft. standard return-tubular boilers set with the Chicago Smoke Inspection Department's No. 8 furnace. Steam is carried at about 100 lb. gage pressure. The assembly-hall blower is driven by a 10-hp. motor and the two classroom-supply blowers by 8 x 12-in. steam engines.

Some of the benefits that are derived from this system of heating and ventilating are as follows:

1. There are no horizontal air ducts that cannot be cleaned. All ducts are vertical so that settlement of dust in them is reduced to a minimum. The tempered-air space under the corridors is so large, the air movement is slow, and as a consequence dust that is drawn in from the outside settles in this tunnel space, from which it can be washed out daily through the drains by flushing from the hose connections.

2. The design is less costly than the plans formerly used, as much of the sheet-metal work is eliminated.

3. The system is flexible in that if only a few rooms are to be used, just that part of the building in use need be heated, as each individual group of reheating coils is separately controllable. The arrangement also provides for adjustment so that rooms on one side of the building may receive more heat than those on the other side, depending on weather conditions. With the plenum system of ventilation it has been our experience that this factor is not as flexible as it will be with the new design.

4. The arrangement permits to a considerable extent the opening of classroom windows without disarranging of the entire ventilating system in the building.

5. In a recent design of school building the basement has been omitted. This makes it difficult to make changes in the mechanical and electrical equipment after the building construction is completed. With the system designed for the Orr and Falconer schools, all the benefits of the basement-type construction are obtained in so far as the mechanical and electrical equipment is concerned, and repairs and alterations to pipe work can be made readily. Additions to the building can be made by extending the rooms at each end of the corridor, increasing the size of the classroom blowers up to the limit of the boiler capacity.

Hy-Pres Oil Pump

A pump that has a combination of variable capacity, constant speed and constant pressure, is found in the Hy-Pres oil pump, which is positive-acting and in which the volume of liquid handled can be varied while the speed of the pump remains constant. This performance of the pump, which is manufactured by D. H. McCorkle Manufacturing Co., Oakland, Calif., is made possible by the use of synchronously rotating two engaged bodies of different diameters on different centers. Referring to Fig. 1, *A* is the rotor mounted on a driving shaft; *B* is the inner rotating carrier ring, these two parts revolving in synchronism on their two centers; *C* is the abutment of the outer casing, and *D* is one of the vanes. The rotating carrier ring *B* is driven in synchronism with the rotor *A*, but revolves on a different center. The vanes are slidably pivoted in the rotor and pivotally carried in the carrier ring. This mechanical construction relieves the vanes of all driving or cramping strains and at the same time provides a positive mechanical means of keeping them in their proper adjustment during the revolution. The rotating carrier ring *B* has three large rectangular ports in its periphery, which register with the inlet and outlet in the main casing *C*.

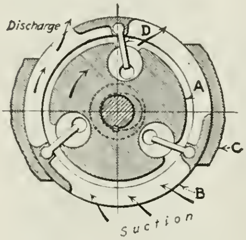


FIG. 1. ROTOR AND CARRIER RING CONCENTRIC

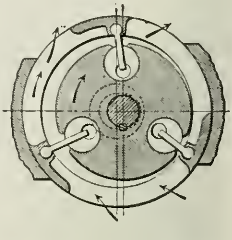


FIG. 2. ROTOR ECCENTRIC TO CARRIER RING

In operation, referring to Fig. 1, the center of the rotor *A* and the center of the rotating carrier ring *B* are concentric, and as the displacement is equal on all sides, the parts will rotate without displacing any liquid. By means of an external adjusting handwheel the center of the carrier ring can be moved in a horizontal direction along the center line, as in Fig. 2, and in this position the displacement diametrically across the pump on the center line is unequal. It will thus be seen that the displacement between members *A* and *B* is unequal, and that the volume of liquid forced through the pump depends on the degree of eccentricity between these two revolving parts. The adjustment can be made as slowly or as rapidly as desired, allowing the pump capacity to be varied without affecting the pressure.

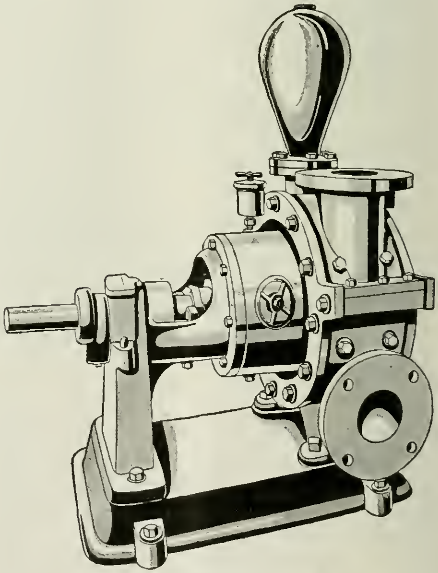


FIG. 3. HY-PRES OIL PUMP

EDITORIALS

Fallacies in Boiler Operation

IN A paper read before the American Boiler Manufacturers' Association at its recent meeting in Buffalo, Dr. D. S. Jacobus said some things that will bear wider circulation; not that he uttered new truths, but that he emphasized, in that casual way which is one of his charms, some fallacies not broadly enough recognized as such. Dr. Jacobus enjoys the distinction of being a premier in boiler matters, therefore his words have weight.

One fallacy to which he refers is the importance, as an indicator of boiler efficiency, of certain percentage contents of carbon dioxide in flue gases, particularly where firemen are paid a bonus based alone on this product of combustion. He says, "How high a percentage should be aimed for depends upon the form of furnace and the furnace volume. Ordinarily, with coal it does not pay to exceed about thirteen-and-one-half per cent." It may be said that for many installations one should become suspicious when the percentage of carbon dioxide exceeds fourteen. When it does, with coal as fuel, there usually is present enough carbon monoxide to offset the apparent gain indicated by the high carbon-dioxide content. The aim should be in most installations to get the highest carbon dioxide with no, or but a trace of, carbon monoxide.

When bonuses are paid on a carbon-dioxide basis alone, the firemen will soon discover that "juggling" of fires will net the greater returns although it may cost the owner more than it's worth. But experience shows that firemen might better strive for high carbon-dioxide content than not strive at all. Exerting conscious effort to produce what, broadly speaking, is an indicator of efficiency, they do get somewhere on the road of improvement.

Another fallacy to which he called attention is that of presuming that average flue-gas analysis combined with the known percentage of carbon in the ash is a measure of the efficiency of the furnace. This leaves out of consideration the fact of secondary combustion. Of course all combustion should be completed in the furnace; it should not continue along among the tubes, even away back to the uptake end. Delayed combustion is better than little or no combustion, when there are combustible gases passing through; but results will make it worth while to try to complete the combustion in the furnace proper.

"A general impression prevails that test results are one thing and operating results another, and that the operating results necessarily fall considerably below the test results. There is no reason why this should be so in the majority of cases." It will be a long time before power-plant men will be so convinced of this that there no longer will be cause to make the statement. Most men like to nourish the belief that there is an unbridgeable gap between everyday operation and test operation. But is it so? Not in modern plants, at least. It is the boiler room where the great sources of waste are located, and until recent years it has been the boiler room which was the most neglected part of the plant. But the modern boiler room is much different, particularly if the plant is of large or moderately large capacity. Everything is quite automatically done, even to the breaking and discharge of the ash. The control board is formidable with instruments which, with the intelligence now usual in such plants, enable such exactness of control as to insure without inconvenience a standard of operation equal to that had on tests.

Second-Hand Equipment

DISMANTLING and reduction in size of many of the plants engaged in strictly war work has caused the market to be flooded with large quantities of second-hand machinery and equipment. The matter of deciding whether it is advisable to purchase second-hand equipment of this nature or to install new material confronts many buyers at this time, and the question is an important one because the purchase of the used equipment, if rightly done, offers great possibilities for saving and quick deliveries.

Probably the greatest source of trouble in connection with second-hand purchases is that the average buyer is tempted to purchase such apparatus because it is cheap—even though it does not exactly suit his requirements. Unless used equipment is just the size and type suited for the conditions to be met, it is undoubtedly good policy to let it alone and invest in new machinery, which will do the work at the best efficiency and at the least cost, because the difference in initial outlay can soon be wiped out by increased operating costs.

If used machinery of the proper capacity and type is available, then a careful study of its age, condition, performance, etc., should be first made. This is especially important in the case of pressure vessels. Usually, some information as to its condition can be obtained from the plant in which it was originally installed, but it is frequently advisable to check this information by applying direct to the maker of the equipment, giving sufficient information to enable him to identify it from his records, and then asking for details as to its performance, date of installation, probable life in active service, and also its present cost if new, which last is of value in determining the reasonableness of the price asked. It will usually be found that the manufacturer's recommendations along these lines are well worth while because in the long run he is interested in upholding the reputation of his equipment and endeavoring to prevent a "trouble case" or bad reference.

No second-hand machine ought to be purchased without a personal inspection to determine its physical condition, the completeness of its parts, etc. Inspection of the fittings and bearings is especially important. Frequently, it will be found that the fittings and fixtures that are missing when the machine is to be installed will more than make up the difference in cost between a used machine and a new one.

Summed up, the purchase of used or second-hand equipment that is fully adapted to the new working conditions, is in good operating condition and is considerably lower in price than new equipment constitutes a good "buy" in the vast majority of cases, but the prospective purchaser should take some pains to determine whether the points mentioned are fully and satisfactorily covered, and not be swayed by the human impulse to "jump at a bargain," just because it is something cheap.

Reverse-Current Relays

DURING the early days of the electrical industry the problem of the protection of circuits and equipment was one in which the chief concern was given to disconnecting the fault as quickly as possible. This generally could be accomplished by the use of fuses or circuit-breakers with an instantaneous trip. However, as the size of electric-power systems increased and they were complicated with a multiplicity of circuits and apparatus, and the necessity of continuity of service became an important matter, the problem of protection developed into one of not only protecting the apparatus, but also of localizing the fault to the circuit on the piece of apparatus where it occurred. To meet the various conditions of protection required for machines operating in parallel or in parallel with other equipment, or for isolating the faulty circuit in the various feeder systems, there has been developed a number of different types of relays. Among these devices the reverse-current relay has, especially in the protecting of direct-current circuits and apparatus, a wide application.

One of the prime applications of reverse-current relays is for the prevention of the reversal and the discharge of current from a storage battery into the charging source should the voltage of the charging equipment fail. In addition to this there are numerous other applications where the reverse-current relays may be used. Rotary converters operating in parallel with a stand-by storage battery is another case in which a highly sensitive relay of the reverse-current type is required. Or where rotary converters are operated in parallel, if the alternating-current supply fails on one machine it will be motorized from the direct-current bus. Even if the alternating-current supply is interrupted only for a short time, it is unsafe to run the converter inverted although the power consumed is very small, since it may run at damaging speed, and in any case, were the alternating-current supply to be established after a very short interruption, the converter would not be running in synchronism and might cause considerable damage. Therefore the reverse-current relay must be highly sensitive and trip the breaker immediately upon a slight reversal of power in the direct-current end.

There are many instances in which reverse-current relays may be applied to give protection to direct-current apparatus and to preserve continuity of service in case of failure of line or machines. While their general use has been limited by the initial cost and the relatively small size of direct-current transmission systems, they are becoming more and more to be recognized as an indispensable factor in the correct operation of any plant. Another reason why they have not come into more general use in the various plants is because the users of the electric energy have grown into the habit of considering an interruption as an unavoidable evil. Were the protective relays better understood, it would at once be realized that interruptions are not necessary evils, but that a large percentage of them on many of the smaller power systems may be avoided by the proper use of protective relays. In an article, "Reverse-Current Relays—Principles of Operation," in this issue, Victor H. Todd describes the principles of operation of a number of different types of reverse-current relays and their applications. A better understanding of the principles of operation of these devices by those who are responsible for their reliable operation will be of great assistance in getting out of the devices that for which they are designed and provide insurance against shutdown.

The perpetual-motion man is again abroad. We have received an attractive-looking circular put out by the United Powers Company, San Francisco, California, heralding the great possibilities of a six-hundred-horsepower fuelless engine. It is said to be the invention of one C. C. Thorn, whose name appears as general manager of the company. But not only have they to offer a six-hundred-horsepower engine requiring not a cent for fuel, but as a side line there is an electric augmentor possessing, according to the circular, the wonderful ability to multiply electricity from four to fourteen times, and still "not a cent for fuel." Oh, yes, a whole page is devoted to the great returns which the unsuspecting investor is to receive.

There is need for closer coöperation between the designing engineer and the architect. The latter always holding the architectural features paramount and usually with a very superficial knowledge of the mechanical details of the power plant, is sometimes responsible for conditions that lead to inefficient operation.

Don't forget that the erecting man may be laboring under adverse conditions with no shop facilities at his command. Therefore, see that the machine leaves the works only after careful inspection and accompanied by all the necessary accessories and tools. It may save days of delay.

The index to Volume Forty-nine of *Power*, covering January to June, 1919, inclusive, is now ready and may be had upon application. If you have saved your back copies, don't fail to get one so that your volume will be complete.

Power-plant records count when they can make a good showing in the balance sheet, but the bookkeeper takes joy out of life when he discloses losses that counterbalance apparent gains.

One rain drop won't make a crop and one Thrift Stamp won't make a fortune, but both usually bring others of their kind with them.

Keep your Liberty Loan interest working for you by investing it in War Savings Stamps.

Correspondence

A Disordered Shaft Governor

The style of governor used on the three vertical compound high-speed engines that drive the electric generators in a large office building is shown in Fig. 1. These governors were originally provided with roller bearings for the pivot pins at the points of attachment between the inertia bars and the spring connectors. A cross-section of these bearings is shown in Fig. 2.

A recent overhauling of the engines revealed that at some previous time the rollers had been removed from these connections, thus leaving each 3/4-in. pivot pin resting upon the periphery of the 1 5/8 in. hole in which the entire bearing previously had been housed. This condition is shown in Fig. 3. That the governors had been running this way for a long period was attested by the fact that the pins were worn oval in cross-section and had hollowed out recesses at their places of contact to a depth of over 1/4 inch.

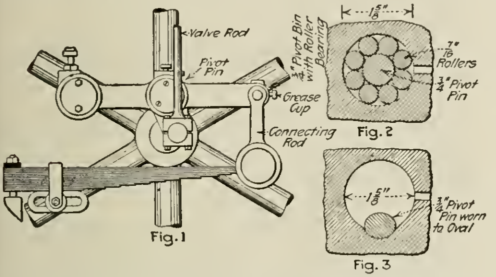


FIG. 1. TYPE OF GOVERNOR EMPLOYED. FIG. 2. PIVOT PIN ROLLER BEARING. FIG. 3. BEARING AS IT HAD OPERATED WITH ROLLERS REMOVED

Notwithstanding this the governors had continued to give fairly good regulation, indications that there was anything seriously wrong with them having been manifested only when wide variations of load occurred. At such times the engines would stagger, perceptibly for some seconds before the governors could adjust themselves to the altered conditions. A. J. DIXON.

St. Louis, Mo.

Don't Take Chances with the Synchronoscope

I was deeply interested in F. J. Gillooly's article, "Don't Take Chances with the Synchronoscope," in *Power*, Apr. 29th issue, since it brings to my mind similar incidents. An operator was synchronizing a 5000-kw. slow-speed alternator direct-connected to a Corliss engine. The alternator had its separate bus-selector and main oil switches. After the operator had closed the main switch, the synchronoscope continued its travels. He then discovered that he had forgotten to close the bus switch; and almost as quickly closed it. In about a minute he opened the switch again, and for half an hour the engineers were busy adjusting the valve gear of the engine, which had been completely thrown out of adjustment by the disturbance of the alternator, which would not pull into step.

In a 5000-kw. plant, where the engines were of an old type and the load carried subject to wide swings, the synchronizing was done with dark lamps. The oil switches were of the "barrel" type. Their tanks were under the switchboard, and they were operated by a rod mechanism with a wheel handle. The switches made a wiping contact by being revolved successively from "Off" to "No. 1 Bus," "Off," "No. 2 Bus" and "Off." The rod carried a pointer which indicated on a dial on the floor the position of the switch. As too strong a turn of the handle would operate the switch beyond the point intended, the attendants made a practice of placing one foot on the dial as a pointer stop.

After a particularly trying siege of synchronizing, one operator gave so savage a turn on the handle that the pointer not only failed to stop at his foot, but traveled up over his shoe and held him prisoner by his toe. To free his foot meant taking the machine off the bus and resynchronizing it against the other already overloaded units.

In the 11,000-kw. plant supplying the combined load of a fair-sized city all the primary equipment was located in a basement switchroom. The potential transformers, with their fuses attached to them, were mounted above the oil switches, out of sight from the floor, and near the open busbars, which were protected only by wooden barriers between phases. An operator was being trained, and while synchronizing a 2500-kw. turbo-alternator, he became nervous and closed the switch about 90 deg. out of phase. Then, at the first groan of the generator he tripped the switch out, never giving the machine a chance to settle down and drop into step.

On stepping up to do the job, the regular operator found that he could get no voltmeter or synchronoscope indication. Somewhere "down the cellar," he knew, there was a fuse blown; but the stuff down there was too crowded and dangerous and altogether "too hot for him to go snooping around" in search of an open circuit. Reserve units were not kept warmed up for emergency use in that plant. To turn over the auxiliaries and start another unit might consume an hour. The engineer was anxious to get some load off the running machine, which had become overloaded before the second one was started, as was the customary procedure. He was so insistent that the operator had to accede to his demands. All load was dropped off the bus; both machines were slowed down, then brought up together to speed and voltage with their switches closed on the bus; and the second machine made to carry load with only its ammeters registering.

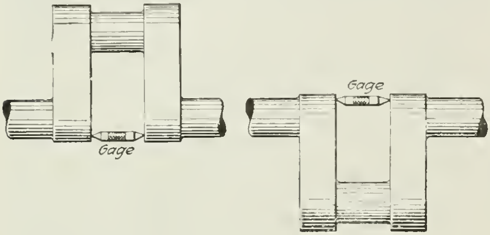
All of which indicates that the layout of the instrument and control wiring and the location of all fuses and other apparatus should be the intimate knowledge of the operator. R. A. PHILLIPS.

New York City.

Testing Crankshaft Alignment

I have recently learned a new method of testing the alignment of gas-engine crankshafts, which is giving good results, and I pass on the idea in the hope that it may prove useful to others. Place the crankshaft on its top center and with either a micrometer gage or one made of round iron, gage between the crank webs at the bottom. Turn the crankshaft around till it is in its bottom position and gage again. It is likely that a surprise is in store when this is done. When the amount that some of them will open is observed, one will not be surprised that so many gas-engine crankshafts break. Usually, it is the bearing on the driving side that is low. A. BENNETT.

Wigan, Lancashire, England.



TESTING CRANKSHAFT ALIGNMENT

Cooling-Water Temperature

The vital necessity of a reduced flow of cooling water on low loads in Diesel operation seems not to be generally understood by the oil engineer. With gas or gasoline engines with quantity control or constant explosion, the amount of air drawn into the cylinder, as well as the amount of gasoline vapor, is generally regulated according to the load. On low loads the air suction is choked, producing a lower air pressure in the cylinder at the beginning of the compression stroke. This, of course, results in a lower final compression pressure of the mixture of air and gaseous vapor. In order to raise this to the highest possible value, thereby improving the efficiency, it is always advisable to reduce the cooling-water flow. Doing this raises the cylinder temperature, and likewise the terminal pressure. However, the gas engine will successfully fire the charge practically regardless of the pressure carried, the limiting factor being the leanness of the mixture. The gasoline, being completely vaporized, is of course easily ignited.

The fuel charge of the Diesel engine is injected into the cylinder in a rather undivided condition in comparison with the vapor charge of a gasoline engine. The ignition is achieved solely by the high temperature of the air charge, which at full load will be around 1050 to 1400 deg. F. This temperature is the result of the compressing of the air by the engine piston further augmented by the absorption of heat from the cylinder walls.

Such high temperature is necessary to ignite the relatively large globules of fuel oil. If the temperature is reduced below a certain degree, dependent on the kind of oil, etc., no ignition will occur. If the temperature is dropped below 1000 deg. F., the combustion will be faulty.

Since the fuel charge is small on low loads, the amount of injection air blowing into the cylinder is greater than at full load. This air, expanding from a pressure of 900 lb. to 500 lb., chills the oil and the cylinder air charge, thereby making the ignition difficulties still more pronounced.

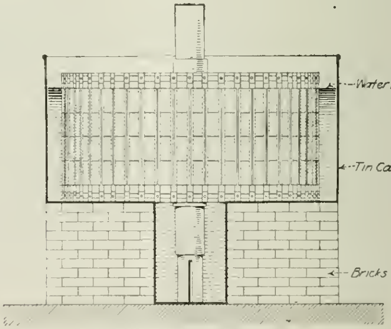
It is then apparent that the temperature, and consequently the compression pressure, of the cylinder air charge must be kept up to normal on low loads. If the cylinder-wall temperature remains constant, then the compression pressure will have a constant value, for the volume of air drawn into the cylinder is always the same at constant temperatures. To obtain a constant wall temperature it is necessary to reduce the flow of cooling water on low loads. The amount of heat evolved from the fuel combustion is reduced, and consequently the amount of cooling water required is likewise reduced. In fact, it is of advantage to reduce the flow until the discharge temperature shows an increased value of from 10 to 15 deg. F. Undoubtedly it would be an improvement if manufacturers placed the cooling-water flow under governor control. E. E. SNOW.

Philadelphia, Penn.

Method for Welding Induction-Motor Rotor Bars to End Rings

We were experiencing considerable trouble with keeping the end rings soldered to the rotor bars of 10-hp. alternating-current induction motors used to drive our freight elevators. The soldering was done in a local electrical repair shop, but as the price of labor and material went up so did the bills for repairs. It was decided to have the bars welded to the end rings if possible, but we were informed that this could not be done as the high temperature due to welding would destroy the rotor slot insulation. However, after some consideration of the matter it was decided to put the rotor into a tin can, made for the purpose and filled with water, as shown in the figure. The can was filled until the water came just above the rotor's slot insulation, leaving the end of the bars and end ring to be welded above the water. The bars were welded to the rings with Tobin bronze, the rotor dried out and balanced and the machine put back into service. The first machine that had its rotor conductors welded has been driving a freight elevator for about five months without any sign of trouble. The cost of welding was about one-third that of resoldering. THOMAS SHEEHAN.

Springfield, Mass.

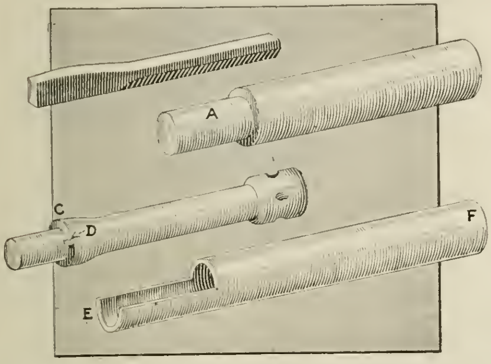


ROTOR PLACED IN CAN OF WATER

Handy Tools for Surface Condenser Work

Considerable time can be saved when removing, replacing and repacking surface condenser tubes if the proper tools are utilized. The tool first used will depend upon whether the tubes are expanded into the tube head or whether the packing is held in place by the ordinary threaded and slotted ferrule. If expanded into the head, the first tool needed will be an ordinary rectangular ended calking tool with which the slight flange or bell of the tube can be turned in. This tool can be easily forged from a piece of hexagon tool steel as shown at the top of the illustration, the working end being about one-quarter inch thick by three-quarters inch wide and length of an ordinary chisel.

The second tool, called the backing-out tool, is made from a piece of cold-rolled steel, the diameter being the same as the outside diameter of the tubes. One end is turned down for two or three inches to a diameter slightly less than the inside diameter of the tube, as shown at *A*. When the tool is driven into the tube, the shoulder will force the tube out of the head enough to permit of its being removed.



TOOLS FOR CONDENSER WORK

In case the tube ends are packed, a tool similar to *A*, with a crosspin inserted just against the shoulder *C* and made to fit the slot in the ferrule, is used, the diameter of the smaller end being slightly less than the inside diameter of the tube, and the diameter at *D* back of the shoulder the same as the outside diameter of the ferrule. The head end can be made hexagonal so that a wrench can be used on it, or it can be drilled as shown with two holes at right angles through which a bar can be inserted for turning it to back out and screw in the ferrules.

In replacing the tubes it is sometimes necessary, if they are of an unusual length for this diameter, to insert a rod into the tube of slightly greater length than the tube in order to feed it through the baffle plates and into the opposite head. In case the end of the tube sags down, an ordinary piece of round iron can be slipped through the tube sheet and into the tube, permitting the feeding of the tube into the tube sheet.

The next operation is to expand the tubes into the sheet with a regular expander for this purpose, or in the absence of one, the tubes can be swaged into place with a bluntly tapered tool that will expand the end of the tube while some one holds a backing-out tool against the other end.

If the tubes are packed in with either corset lace or fiber ring, a packing tool is made by taking a piece of the tubes in use and grinding away one-half of it for a length sufficient to reach the bottom of the stuffing-box and then expanding the remaining half to a circumference slightly greater than the tube but just so it will go into the packing space.

The bottom illustration shows the manner in which the tube is ground away so that *E* presents a semicircular end which will enable one to pack the tube ends in a rapid and satisfactory manner by driving on the end *F* lightly with a hammer. After sufficient packing is in, the packing wrench *C* is brought into use and the ferrule is tightened up, ready for a test to see whether a tight job has been made.

There are two methods of making this test. One way, which usually requires considerable time, is to fill the steam space with water and look for drips from the tube ends. A more speedy way is to start the air pump, which will exhaust the air from the steam space and at the same time cause air to be sucked in through any ruptured tube or leaky packing to the extent that it can be easily heard and traced by simply running the hand flatwise over the tube ends; or if there should be too much noise from the outside, by using a candle over the ends of the suspected tubes, the flame of the candle being drawn in wherever there is an air leak of any importance. F. M. STERLING.

Canton, Ohio.

Testing Boilers for Air Leakage

Practically every up-to-date boiler plant has a flue-gas analysis instrument. In most cases this instrument is used only as a check on the fireman, to see if he is giving proper attention to his fires. An instrument of the portable type may be made valuable in finding out whether a boiler setting is air-tight, the amount of the leakage and the approximate position of the leaks if there are any. This may be done by taking quick CO_2 readings in different parts of the setting. If the setting is tight, there should be no difference in the reading between any two points.

First readings should be taken between the first pass and the damper. If no drop or only a slight drop is obtained, the setting is air tight and no further search is necessary. Care should be taken that the reading in the first pass is taken far enough along the pass to have proper combustion and thorough mixing of the gases.

If a drop is obtained, readings are taken between passes until the drop is located between two points. It may then be exactly located by means of a torch. If the search for leaks can be narrowed down to a small part of the setting, a much better job can be done in stopping them. Moreover, there is no guesswork about when they are stopped up. A few readings will tell whether they are stopped or not.

My experience has been that the losses due to small air leaks are not appreciated. Separately they may not be large, but the total may be considerable. The method I have described, not original by any means, but not used as much as it should be, will tell just how serious the air leaks are; and when repairs are made and thought to be complete, it will tell whether any holes have been overlooked. W. D. TAYLOR.

Connellsville, Penn.

Slow Engine Speed and Condensation

One morning it was noticed that the blower engine driving the boiler forced-draft fan failed to come up to speed when the steam dropped a little. An examination of the engine failed to disclose anything amiss until the cylinder head was removed, when it was discovered that the piston had no rings, but two small pieces were found. This engine was located in the boiler room and was under the care of the firemen, but on making inquiries nobody knew anything about the engine getting a slug of water.

A few days after new rings had been put in, the chief was standing by the engine, which was running slowly, when a sudden demand for steam caused it to speed up quickly and a sharp clicking in the cylinder, indicating water, caused him to open the drain-cocks. The fireman said that this frequently happened, and then the chief knew that the cause of broken rings was water.

When the engine was running slowly, condensation formed in the steam line and a sudden demand for steam would carry it into the engine cylinder.

Boston, Mass. FRANKLAND CHENEY.

The Selk Safety Stop

Several years ago when I took charge of the steam plant of the Brooks-Scanlon Lumber Co., Bend, Ore., as chief engineer, I found that the 26 x 42-in. Corliss engine with an 18-ft. flywheel was not provided with a safety stop, so I invented the stop shown in Figs. 1 and 2. The arrangement worked so well and was so sensitive that I applied for a patent, which is now pending.

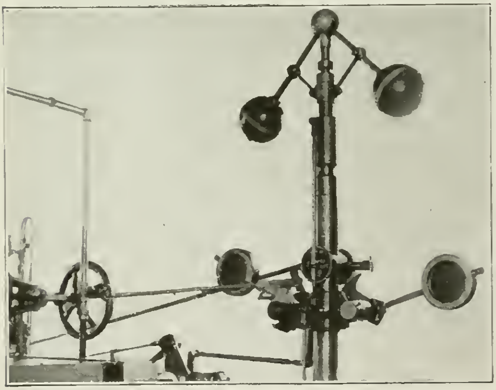


FIG. 1. WEIGHTS IN TRIPPED POSITION

The working arrangement is such that when the throttle is open, the latch lever is pushed toward the governor, as shown in Fig. 1, where the weights are down. When the throttle is closed, the latch rod is drawn back toward the throttle valve by a curved spring, a collar on the throttle-valve stem moving inward as the valve is closed, which allows the spring to draw the latch rod back so that the collar on the upper gag-pot stem will pass the end of the latch or short trip lever without tripping the weights.

In case anything should happen to the governor when the engine is running, the governor balls will drop. This action will trip the latch and the two weights will fall from a vertical position, Fig. 2, to a horizontal position, Fig. 1, and in so doing push the upper gag-pot stem upward to its limit and spread the governor balls out as if in full motion, only more so. This action will move the two trip cams on the engine steam valves to such a degree that the crab claws will not catch there by allowing the steam valves to remain closed, and the engine will come to a stop.

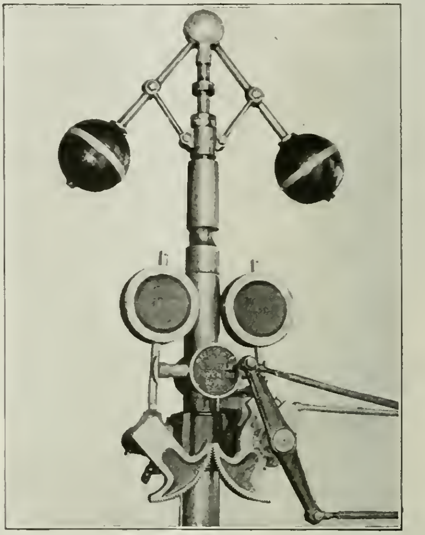


FIG. 2. WEIGHTS SET FOR TRIPPING

It is then necessary for the operator to push the two weights back to a vertical position before steam can be admitted to the engine and the arrangement is again in operation. This is a reliable safety stop and has been in use two years and during that time it has been thoroughly tested. It can be electrically operated from any distance. G. J. SELK.

Bend, Ore.

Owners Should Supply Instruments

When shall we have the operating engineer strongly advised to carry around with him a CO_2 recorder, a draft gage, a pyrometer, a few thermometers, etc.? Surely, instruments enumerated are as much to be desired as an engine indicator, and any of them is much cheaper than the latter instrument.

Candidly, I am of the opinion that if the owner of a plant cannot provide an engine indicator where reciprocating engines are in operation, then no sympathy should be extended to him if his fuel bill is high. I consider that it is not up to the operating engineer to buy such an expensive instrument as an indicator. Educate the owners, you engine builders, boiler manufacturers and power-plant designers, and impress on them the necessity of having the necessary instruments in the plant. J. B. TAIT.

New Westminster, B. C., Canada.

No responsibility should be placed on a man until he has confidence and knowledge to do the work.

Inquiries of General Interest

Testing Safety-Valve Capacity—What test can be made for determining whether a safety valve is large enough for a boiler? D. M.

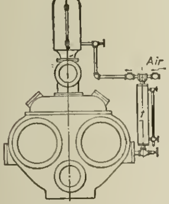
To be of sufficient capacity, a safety valve must be capable of relieving the boiler of steam at such a rate that the boiler pressure cannot be raised above the safe working pressure when the firing is forced as much as possible, and there is no steam escaping except through the safety valve. Such a capacity test should be made by gradually increasing the rate of firing, but should not be made without having means available that are known to be reliable for immediately checking the fire and also for relieving the boiler of steam, in case there is any increase of pressure above the safe working pressure for the boiler.

Employment of Motor or Utilization of Exhaust—When 50 hp. is required for driving a paper-making machine, would it be more economical to drive with an electric motor and supply steam for drying the paper, or to drive with an engine and use the exhaust for drying and for heating water? J. J. H.

The question hinges mainly on the cost of electric power. Under ordinary conditions, after the live steam required by the engine is converted into exhaust, it may be utilized for performing 65 per cent. as much heating as if used directly in the form of live steam. Hence, with an electric motor there would be about two-thirds as much steam used, and for superior economy in use of a motor the cost of electric power delivered to the paper machine would have to be less than one-third the cost of live steam required to be delivered to the engine.

Loss of Air from Pump Air Chamber—What causes loss of air from the air chamber of a pump, and how may it be remedied? W. T.

Water under atmospheric conditions contains about 2 per cent. air in solution and when in contact with air at higher pressure, more air is absorbed by the water. Consequently, the volume of air in an air chamber that is connected on the pressure side of a pump becomes reduced. The figure illustrates an air-charging device that utilizes the varying pressure in one of the pump chambers to compress air into the air chamber. A vertical tube *t* is attached to the side of the pump body and is in communication with the inside of one of the pump chambers. The upper end carries two check valves, one for suction and one for discharge, communicating with the air chamber. The pulsations in the pump chamber produce similar pulsations in the tube, thus forming an effective air compressor, without danger of the air entering the pump chamber.



Water Delivered by 6-In. Pipe Line—With 25 ft head what quantity of water can be delivered through a 6-in. cast-iron pipe 1000 ft. long? T. J. C.

The highest rate of flow will be obtained when the whole head is absorbed in overcoming friction at the entrance and pipe friction and in producing the velocity with delivery from the discharge end at atmospheric pressure. With 25 ft. head available a clean 6-in. cast-iron pipe line 1000 ft. long, with delivery at atmospheric pressure, would discharge about 500 gal. per min. For delivery of 400 gal. per min. the loss of head would be about 15 ft., leaving a discharge head of 10 ft.; for 300 gal. a loss of head of about 8.5 and discharge head of 16.5 ft.; for 200 gal. a loss of head of about 4 ft. with a discharge head of 21 ft.; and for 100 gal. per min. a loss of head of about 1 ft. with a discharge head of 24 ft.

Current per Terminal in a Three-Phase Circuit—Each of the lamps in Fig. 1 takes 5 amperes, which is in phase with the voltage applied to it. What is the value of the current flowing in each line wire? The generator is connected in star and gives a correct three-phase voltage. E. C. B.

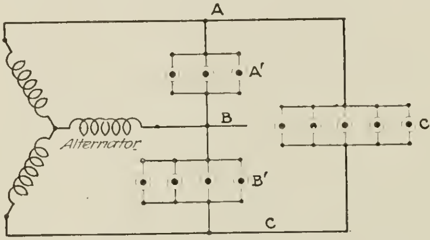


FIG. 1. DIAGRAM OF ALTERNATOR AND LOADS

Since each lamp takes 5 amperes, load A' will take $3 \times 5 = 15$ amperes, load B', $4 \times 5 = 20$ amperes and load C', $5 \times 5 = 25$ amperes. The different currents are in step with the voltage across their respective circuits, therefore they are 120 deg. apart and may be shown vectorially as in Fig. 2. The current in line A is the vectorial sum of loads A' and C', that in line B the vectorial sum of loads A' and B' and that in line C the vectorial sum of loads B' and C', flowing toward or away from the respective conductors. Then by combining the loads in Fig. 2 vectorially, as shown in Fig. 3, the resultants A, B and C will represent to scale, respectively, the value of the current in A, B and C, Fig. 1. In Fig. 3

$$A = \sqrt{(A')^2 + (C')^2 + 2A'C' \cos 60 \text{ deg.}}$$

$$B = \sqrt{(A')^2 + (B')^2 + 2A'B' \cos 60 \text{ deg.}}$$

$$\text{and } C = \sqrt{(B')^2 + (C')^2 + 2B'C' \cos 60 \text{ deg.}}$$

As cos 60 deg. = 0.5, then,

$$A = \sqrt{15^2 + 25^2 + 2 \times 15 \times 25 \times 0.5} = 35 \quad \textit{amperes}$$

$$B = \sqrt{15^2 + 20^2 + 2 \times 15 \times 20 \times 0.5} = 30.4 \textit{ amperes}$$

$$C = \sqrt{20^2 + 25^2 + 2 \times 20 \times 25 \times 0.5} = 39 \quad \textit{amperes}$$

That is, the current in A conductor, Fig. 1, is 35 amperes, in B conductor 30.4 amperes and in C conductor 39 amperes.

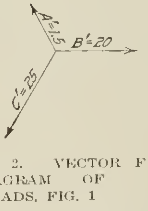


FIG. 2. VECTOR DIAGRAM OF LOADS, FIG. 1

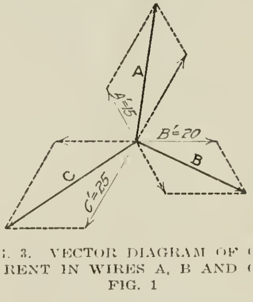


FIG. 3. VECTOR DIAGRAM OF CURRENT IN WIRES A, B AND C, FIG. 1

Factors in Obtaining Maximum Output from Hydro-Electric Plants*

By FRED A. ALLNER
General Superintendent, Pennsylvania Water and Power Company, Baltimore, Md.

THE following refers to a 100,000 hp. low-head plant, located on a river, the latter having a protracted low-flow period interrupted occasionally by freshets. By means of high-tension transmission lines the plant is tied in with several steam stations of about equal total capacity. During the high-flow season the water-power plant operates at high load factor, running wide open for about sixteen hours. The steam plants carry the peaks of the load. During the low-flow season the steam plants operate at nearly 100 per cent. load factor, while the water-power plant carries the peaks.

High-Flow Season — When the river flow exceeds the power-house draft, maximum output of the hydraulic plant is obtained by (1) Operating main units in wide-open condition for the maximum possible number of hours; (2) adusting gate-operating mechanism in such manner that wide-open condition of operating piston actually produces maximum clear opening of guide vanes; (3) using high-flow flashboards; (4) carrying a minimum of wattless current at the water-power plant; (5) operating a minimum of alternating-current-driven excitation and station auxiliary apparatus during the wide-open hours; (6) improving ventilation by blowers and proper directing of air to hot parts of generators, if hydraulic output exceeds the electrical rating of some units; (7) careful inspection and preventive maintenance of all apparatus that when out of service may reduce station output; (8) organizing necessary low-flow overhauling work so that it can be completed in a minimum of time.

Low-Flow Season — When the river flow is less than power-house draft the maximum hydro-electric energy for a given river flow is obtained by (1) Distributing total station load on smallest number of turbines consistent with load conditions, so as to cause a minimum of water draft through the power house for a given load at any time; (2) holding forebay at highest possible elevation; (3) efficient use of low-flow flashboards; (4) transferring wattless current to steam units and synchronous receiving apparatus, if same can be carried there at a lower over-all loss; (5) distributing excitation load between waterwheel- and motor-driven units for minimum water consumption; (6) reducing station power requirements for auxiliaries to a minimum consistent with safety.

A number of the high- and low-flow features enumerated had been practiced for several years at the plant under discussion, but found a more thorough application during the war period through more stringent follow-up methods.

Some other features were introduced under wartime pressure that promise useful application in the regular operation of the plant.

Knowledge of Individual Customers' Loads Essential

Knowledge of the loads of the individual customers, and of the operating characteristics of those steam plants which run in parallel, is essential. Governor adjustments require to be worked out for parallel operating conditions of the various plants, so as to reduce as far as possible the number of occasions when load fluctuations are taken up by the hydraulic plant instead of by the steam plants, during hours when total system load exceeds hydraulic capacity. A daily record showing the amount and specific causes of "Energy Wasted" due to hydraulic plant not being loaded up full, while steam plants carry an undue portion of the load, offers a useful follow-up method for the operating force. These losses may aggregate 50,000 kw-hr. per day (for about 2,000,000 kw-hr. total system load) and even exceed this figure if parallel operation between the plants is not closely watched.

Owing to the cumulative effort of lost motion in gate-operating mechanism, it frequently occurs that wide-open condition of operating piston does not actually produce maximum clear opening of guide vanes. Periodical checks should be made on the output of individual units, and if reductions in output are found, they should be traced to definite causes.

On a certain 10,000-kw. unit, just before the time for overhauling had arrived, this loss of output was about 250 kw., and even on units in fair condition it may easily reach 100 kw. A standard steam indicator mounted on the operating engine is useful for such investigations, as it permits the reading of lost motion in the mechanism and of operating pressure required for moving gates in different positions, etc. If guide vanes and other parts of operating mechanism were originally adjusted correctly, excessive lost motion may be compensated for by increasing the piston stroke without taking the unit out of service. If no provision is made for this in the design, it may be possible in many cases to obtain the increased stroke by substituting a shorter piston head, which can be inserted during off-peak hours.

Increase of output through the use of high-flow flashboards may be quite appreciable. Although using a board of only about half the height of the low-flow flashboards, this gain in output may, under certain conditions, equal or exceed the gain from the low-flow boards.

Reactive Current an Undesirable Element

For a given system load the reactive or wattless current is an undesirable element of the power load that must be furnished by the generating stations, together with the power current. In a combined steam and hydraulic system where the hydraulic plant is usually some distance away from the point of consumption of energy, it will generally be found more economical to let the steam units and some of the synchronous receiving apparatus carry as much of the reactive current as possible. The transmission of undue wattless current through the high-tension lines, step-up and step-down transformers, will increase considerably the metered reactive watts, as carried at the hydraulic station. Transmission losses will increase, and in addition, in order to maintain normal voltage at the point of delivery, a high bus voltage will be necessary at the hydraulic plant, such higher bus voltage carrying with it greater excitation and core losses in the generators.

Installation of reactive wattmeters on the totalizing meter-bus of hydraulic and steam stations and at the points of power delivery at the receiving station is necessary for the study of such load conditions and for the "displacing of reactive load" in regular operation.

Hydraulic stations that do not have a rigid system of excitation such as individual motor-generator sets or exciters directly connected to the turbine shaft offer a certain flexibility in the distribution of excitation and station auxiliary load that may be used to advantage for obtaining maximum output. A plant with partly waterwheel-driven and partly alternating-current-motor-driven exciters, and an emergency storage battery operating in parallel, should, during ample flow periods, obtain as much of the excitation and auxiliary power as possible from the waterwheel-driven exciters during the hours when the main units are operating with gates wide open. Intermittent station auxiliaries should be operated mostly during the off-peak hours, between midnight and morning peak.

The use of high-flow flashboards or other special expedients for securing higher operating head may have the effect of increasing the hydraulic output of turbines beyond the electrical rating of the generators. The generator ratings may then be raised by making provisions for better cooling them. In such cases reliable hot-spot temperature indicators are almost indispensable. If different types of generator units are used in the plant, some increased output therefrom may be obtained by running the lower-rated generators at high power factor and throwing the bulk of the low-power-factor generation upon the units having higher ratings. In some cases even this remedy is insufficient, and it may pay to provide individual blowers to direct air to the hot parts of the generators or arrange the whole plant for a central ventilating system with large blower units.

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*From the 1919 Report, Prime Movers Committee, National Electric Light Association.

Careful inspection of all apparatus at regular intervals is one of the chief requirements of preventive maintenance, as contrasted with mere repairing of breakdowns. This is a large field for the practical maintenance engineer in every hydro-electric plant, although it may show its value only in the course of several years.

During the hours between midnight and morning peak and over the Sunday recess it should be possible in many plants to carry out all the inspection work of the interior of turbines if arrangements are worked out for proper organization of crew and time-saving inspection facilities.

Certain overhauling work that is necessary, due to wear of vital parts, should be completed within a minimum time, so as to keep the unit out of service as short a time as possible. Foreknowledge of the nature of the work, providing in advance the spare parts for renewal and scheduling of the work in advance have made it possible to reduce the time that was originally used for such work to nearly half in this station. On several occasions a quickly approaching rain freshet in the midst of the low-flow season has been taken advantage of by putting quickly into service a unit that was undergoing maintenance overhauling. A week's delay in each case would have entailed the loss of opportunities to utilize the flow from the freshet In one case, for example, it meant an increase of 180,000 kw-hr. per day in delivered energy.

At the same plant a bonus system for the hydraulic-maintenance force has been in use for two years, whereby the crew receives extra pay for each day that it is able to shorten the actual time that a double runner unit is out of service for major overhauling, as compared with the scheduled time.

Under low-flow conditions the principal aim of the hydraulic plant is to produce a maximum of kilowatt hours from a given river flow.

BEST LOAD DISTRIBUTION

The joint operation of the hydraulic and steam plants under discussion required that "best load distribution" should always be understood to mean not only best water economy, but also best combined water and fuel economy. The steam plants, during the low-flow period, are operated as nearly as possible to 100 per cent. load factor, using at first their most efficient units and then placing the additional and less economical equipment into service as the river flow drops lower. The problem of best combined economy is, however, largely a problem of hydraulic economy.

Occasionally, it is necessary to deviate from this rule, because of temporary shortage of fuel or tie-up of coal transportation or handling facilities at one or at both of the principal steam plants.

Of the eight main units of this hydraulic plant the first five have double runners of identical type, two more recent ones have runners of somewhat different characteristics, and the last unit is of a single-runner high-efficiency type. A table has been computed from the various turbine output-discharge curves to assist the operators in distributing the load among the units so as to secure best efficiency.

Holding the forebay at the highest possible elevation is of considerable moment in the operation of a low-head plant. This is quite apparent if it is realized that a faulty estimate of flow or load, or both, on, say, a fifty-foot head plant, with an average connected load of over 2,000,000 kw.hr. per day, but with a storage capacity of only 100,000 kw.-hr. per ft. draw-down of forebay pond, would entail a loss of 1 per cent. of the following day's hydraulic output, if the forebay level when entering upon the morning peak is 0.5 ft. lower than the proper level. This difference in forebay level, however, represents only 2½ per cent. of the system load. It is quite apparent, therefore, that an accurate manipulation of forebay is possible only by a thorough understanding of system local conditions, foreknowledge of flow and closer coöperation with the steam plants.

Flashboards, as a rule, are treated with less engineering care than other station apparatus that is looked upon for yielding the same amount of energy in the daily operation. Leakage between the concrete sill of dam and boards, losses in the vertical and horizontal joints between boards, effect of wave action on the loosening of tightening devices, etc., can reduce the effective gain from flashboards to a considerable extent. On the other hand, proper equipment and organization of crew for tightening the boards, erecting them quickly after a freshet, or removing them intact at the approach of a higher river stage can increase the station output appreciably. The net gain from flashboards in the plant described varied, of course, with the flow, but for an average low-flow stage of 10,000 cu.ft. per sec, and a head of 55 ft., it could be made to exceed 60,000 kw.-hr. per day. Most economical distribution of a given excitation and plant auxiliary load between waterwheel-driven and alternating-current-driven exciters is obtained by the use of output-discharge curves.

Although station auxiliaries, exclusive of excitation, consume only about 1 per cent. of the high-flow station output, it is possible to accomplish a measurable economy by studying the load requirements of the individual apparatus. During extreme low-flow stages the above percentage may double or treble, since certain station auxiliaries are necessary, regardless of amount of station energy output.

In some cases the original layout of a hydraulic plant does not provide for individual watt-hour meters or other instruments to measure the power of the auxiliaries.

Lubrication Problems*

Among the lubricating problems awaiting solution are those relating to the behavior of lubricants at high pressures and temperatures. It has been the common experience of operators that organic oils—for example, lard oil and sperm oil—are much more effective than mineral oils of similar viscosity. The reasons for this are as yet more or less obscure.

It has long been known that high pressure produces measurable changes in the viscosity of certain fluids. It has been found by experiment that lard oil and mineral oil of about the same viscosity at atmospheric pressures showed great increase in viscosity under pressures of 200 to 500 atmospheres. Likewise it is well known that all lubricants decrease in viscosity with an increase in temperature. Viscosity measurements are rarely made at temperatures above 100 deg. C., which is much lower than that reached in severe service.

What experiments have thus far been conducted to show the adhesive qualities of lubricants under these conditions show no slipping at the boundary surface between lubricant and the solid surfaces at moderate rates of shear in the lubricants. Albert Kingsley has experimented with a device consisting of a slightly tapered plug rotating in a ring closely fitted by grinding. The thickness of the oil film was determined by micrometric end adjustment of the plug. With films as thin as 0.000025 in. and rates of shear up to 261,000 radii per second, at atmospheric pressure and temperature, there were no indications of slip. If slipping should take place, then the question would come up whether the results depend upon the nature of the bearing metals.

Lubricants that exhibit oiliness to a marked degree may contain in solution solids which tend to concentrate at the boundary surfaces. This increases the viscosity at the surface and therefore increases the lubricating value at high pressure. There is no direct evidence on this point except in the case of soap dissolved in the water used in hydraulic cylinders. The soap concentrates upon the metal surfaces, forming a good lubricating film.

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*Report of sub-committee on lubrication for representation at the Spring Meeting, Detroit, Mich., of the American Society of Mechanical Engineers, 29 West 39th St., New York.

The Power-Plant Cost Sheet*

By Arthur E. Huntington

Cost of power enters into the cost of manufacturing in largely varying percentages, ranging from only a small percentage on some products up to approximately 33⅓ per cent. of an electric light and power business. In the average manufacturing plant the ratio of cost of power to the total cost is from 7 to 12 per cent. Be that percentage great or small, it is the duty of each engineer to know not only the cost of his power, but to know its relation to the total cost of manufacturing. Many a good engineer has worked for years feeling that his services were not appreciated and that he was not getting the money that was due him—and he does not. Such a fellow has been operating a power house only and has failed to make himself a part of the balance sheet of the concern. It is important that the engineer finds out just what his part of the work is and just how it fits into the whole scheme. It is then up to him to stake out his claim on the balance sheet, defend his rights by making the manager feel that he is individually responsible for from 10 to 20 per cent. of the business and that he can be trusted with it.

Customer Should Have Data Sheet

Any man going after a power customer ought to have first of all a data sheet showing the nature of the load, and including the following items: Maximum load, load factor, power factor on alternating-current circuits, annual load, data as to how the load fits in with other loads, reserve capacity required and whether the reserve capacity already in use can be utilized, with a large space left for remarks, as conditions are continually changing.

It is seldom that a large amount of power can be added to any plant without some additional investment. A data sheet should show just what each of these investment items should be. They may be divided under (1) Power plant, (2) distributing system, (3) going value, (4) other values.

Under the first item the plant capacity required to handle the load should be noted. In large plants quite frequently some transforming devices must be taken into account.

Under the distributing system the investment should include not only the new construction necessary to handle the business, but also a just allowance for joint use made of equipment already in existence. A capital charge against each power customer should be made, even though capacity already available is being used. On each extension the proper procedure is to figure clear back to the cash drawer.

Going value is an item to be considered. Unquestionably, a plant with an established business is worth more than the same plant with no business. All courts and commissions grant such a value, but few of them agree just how much it is or how it should be figured. One commission ruled that the going value was an amount of money equal to interest and depreciation on that part of the plant that is not in use during the development period. In other words, if a plant costs $100,000 and it takes two years to develop the load, if development were uniform the going value would be the carrying charges on a $100,000 investment for one year, or about $15,000. This would be a fair way to figure it were it not for the fact that a plant having an energetic manager would get less going value than a plant with a poor manager. Evidently, if a high going value were desired, it could be obtained by being slow in developing the property.

Others prefer to define going value as the amount of money necessary to develop the business on a certain property and get it onto the line. For present purposes it will be sufficient to say that going value represents the difference between the value of the property as a going concern with the business attached to it, as against the same property without the business. In figuring the investment, account should be taken of the cash required to do business, which includes money tied up in supplies as well as many other items. In a power company this amount usually represents 90 to 100 days' income, and quite frequently intangible assets represent 30 per cent. of the total capital charge. In a manufacturing concern it represents the period that elapses between the time the power bill is paid and the time when the product is sold and the money is in the cash drawer. As an interested party in the balance sheet, the engineer has a right to know for just how long the money which his department costs is tied up.

Determining the Charges That Should Be Made

With the value of all the property established, the next step is to determine the various charges that should be made. Some of these are nearly constant, while others are variable. Under fixed charges, take interest as the first item. Frequently, good business men refuse to consider this item and try to dismiss the subject by saying that the plant is theirs and all paid for and that there is no interest, although the money is in the business and was put there to bring a return. The interest charge should be based on all that it costs to get money into the cash drawer to do business with. The tendency is to figure such items too low.

Insurance, taxes, repairs and upkeep usually have some place on the company's books and are easy to get.

As to depreciation, it makes little difference whether the straight-line, sinking-fund or compound-interest method is used. The main thing is to be sure and set aside enough. No engineer should permit his company to set aside less money than will maintain the plant at all times at about 85 per cent. of standard, or in other words, in a condition that would make it equal to 85 per cent. of a new plant. Without figuring it out exactly, it is fair to assume that the average plant that sets aside 5 per cent. for depreciation could be maintained at an 85 per cent. standard; 4½ per cent. represents about 80 per cent. standard, and 4 per cent. a 70 per cent. standard. This item is sometimes figured at 3 per cent. because some engine that the engineer knows of has been running for a long period of years, without considering that the engine might be obsolete and require an excessive amount of steam. The best method is to figure depreciation on each item separately—engines, boilers, pumps, condensers, belts, shafting, generators, etc. This is much better than taking some fixed percentage and then spreading it over the entire plant. In an electric-light plant these items of interest, taxes, depreciation and upkeep, that come under fixed charges, usually figure about 15 per cent. of the gross value of the tangible assets. For the intangible value 8 per cent. is about the right figure to allow.

Cost of Operation Must Be Included

To the preceding must be added the cost of operation, including labor, coal, water, supplies and incidentals. With this part of the cost sheet the engineer is usually familiar. The main thing is to know what it cost to deliver a kilowatt-hour at the point of use and not on the indicator or switchboard readings. In a test made recently on a certain plant the losses were shown to be more than 66 per cent. of the total power generated. The power company must charge to the cost of production, sales and legal expense, administration, insurance, collection, etc. If all these items in their true value are figured, the engineer will have somewhere near the true cost of power and can show to the management what proportion of the business he represents. If he is a man who takes into the cost of power just such items as coal, labor and repairs, he is not an engineer at all, but a throttle twister. If he knows the costs and makes himself an integral part of the balance sheet, he is a real engineer.

Some men in charge of power plants are fine mechanics, but never get beyond the stage of throttle twisters. Their power houses are always ready, their engines run smoothly and show a fine card whenever the indicator is applied. They really make power at a low cost, yet the management does not value such men highly, because they are not considered a part of the company. They are viewed more as high-class laborers who do not produce anything that is figured into the cost of production more than in a general way. On the books there is a place where power costs are kept, but the engineer never sees it. That part of the book is presided over by a $10-a-week bookkeeper. How many engineers are willing to have their standing with the company valued by a clerk in this way?

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*Abstract of paper read before the Iowa State Association N. A. S. E., Marshalltown, June 13, 1919.

An engineer should be a man of clean personal habits, who has an ambition to be somebody both in his community and with the company. He should be a mechanic and understand how to handle men; he must be able to figure his costs intelligently and to apply that knowledge diligently and continually. He should know and impress upon the management the part that the engine room really plays on the balance sheet and should have at least a working knowledge of business methods. He may not be proficient in all these items, but with a little effort he can become familiar with them, and when he is he can call himself a real engineer.

Progress in Water Power*

Increasing attention is being given to details of design affecting ease of operation of the turbine, and ease of conducting maintenance work on it. Accessibility of parts, better provision for thorough lubrication, removal of gate-rigging mechanism from exposure to the corrosion elements of the water, provision for adjusting pinch-fits of gates, and taking up backlash in the operating mechanism are all in themselves minor factors of improvement, but of importance in the aggregate. Troubles formerly encountered from the use of oil in closed governor system have been done away with by the use of the open reservoir system. Where water is used as an operating fluid in the governor system, the corrosion resulting therefrom and the attendant difficulties are being met in various ways at different plants, as, for example, by the neutralization of the governor fluid with barium-hydrate treatment combined with the use of so-called soluble oil, or of potassium bichromate. Cooling of lubricating oil from thrust bearings seems to be giving some difficulty in the hot-weather climate. It is reported that better results are obtained by using open-air cooling coils, on which the water is sprayed and the cooling effect obtained by evaporation, as compared with the tank coil cooler.

The rapid rusting of intake-screen equipment in corrosive river water is continuing to give trouble in certain plants, and no special paint seems to have been found to afford protection for more than a few years. A very heavy red-lead covering seems to be about as satisfactory a coating as any, and the expedient adopted in one plant is to withdraw and paint a certain number of rack sections each year, the cost of painting being kept down by the use of spray apparatus. The screens are previously cleaned up by sandblast.

Interest is being increasingly aroused in the development of smaller water-power plants consisting of low-capacity remote-control stations connected together to assist in using one or more plants of fairly large size in the master stations.

There is a growing realization of the importance of not only designing a hydro-electric plant for high efficiency, but of providing in its design for the necessary equipment to enable its operating efficiency to be checked and maintained. The building in of piezometer equipment in each turbine intake is recommended, in the case of new layouts, whereby after a calibration of one intake by appropriate water-measuring arrangement, a continuous periodical checking up of each individual unit may be easily obtained, and thus the degree of accuracy of the hydraulic operation of the station ascertained.

The Johnson type of valve is finding increasing use in water-power developments, being now made in sizes as large as 144 in. diameter and valves of 36 in. diameter are being used under heads of 1000 ft. A detailed description of this valve is found in the 1913 report of this committee.

The committee is in receipt of statements from the following manufacturers, covering developments during the year:

The Allis-Chalmers Manufacturing Co. reports the following installations which are given in chronological order: Tallahassee Power Co., Nadin, N. C. Three units, each of 31,000 hp., 180 ft. head. In operation over one year at the present writing. Tallahassee Power Co., Cheoah development, four units, 27,000 hp., 188 ft. head, completely erected. Hydraulic Power Co., Niagara Falls, now Niagara Falls Power Co., three units, 37,500 hp., 214 ft. head. Erection of machinery just started. Hydro-Electric Power Commission of Ontario, Chippewa development, two units, 52,500 hp., 320 ft. head. Contract awarded.

Probably the most novel improvement in connection with draft tubes is found in the hydraucone, which has been applied successfully to quite a variety of installations where operating data are available. This device has been installed in connection with the following plants, on which operating data have become available during the past year. Berlin Mills Co., Shelburn plant, two units, 1200 hp., 17 ft. head. Detroit Edison Co., Geddes plant, 575 hp. Manchester Traction, Light and Power Co., two units, 2175 hp., 63 ft. head. Sheboygan Electric Light and Power Co., two horizontal units, 750 hp., 19 ft. head. Hydraulic Power Co., one unit, 37,500 hp., 214 ft. head.

William Cramp & Sons Ship and Engine Building Co. report: In 1918 there was considerably more activity than in the previous year, the aggregate horsepower contracted for by our company being nearly three times greater than in 1917. One-fourth of the units contracted for during 1918 are for extensions to existing plants.

There was a marked tendency toward the installation of high-powered units, the average size per unit being 17,600 hp. The 37,500-hp. turbine now under construction for the Niagara Falls Power Co., when completed, will be the most powerful turbine in the world. For the turbines contracted for by our company during 1918 the designed head ranges from 130 to 475 feet.

Pelton waterwheels in units as large as 15,000 hp. on a single Pelton or impulse turbine runner and for a head of 2000 ft. have been constructed.

The Wellman-Seaver-Morgan Co. has given considerable study to low-capacity remote-control plants. One centrally located plant of fairly large size can be used as the master station, and several other low-head plants within a radius of 15 or 20 miles may be operated from this plant without attendants whatever, except a man to drop around occasionally. This is merely a necessary condition to make a plant of 100 to 500 hp. a paying proposition.

The largest proposition being developed at present is the Niagara development on the Canadian side, for the Hydro-Electric Commission of Ontario. We have been awarded the contract for the first two units. Each turbine will develop 52,500 hp. at point of maximum efficiency, and about 60,000 hp. at full gate open.

House Passes Water-Power Bill

The House of Representatives has now passed the water-power bill. The bill is substantially the same as the measure which was passed by the House of Representatives at the last session of Congress. No important amendments were made. The measure is now before the Commerce Committee of the Senate, and will be taken up by a subcommittee of that body shortly after Aug. 1, when Senator Jones of Washington, who is the chairman of the committee, is expected to return from a visit he is now making to Seattle. The other members of the subcommittees who will have jurisdiction over the bill for the time being are Senators Nelson, Lenroot, Bankhead and Fletcher. Friends of water-power legislation in Washington hope for the early passage of the bill by the Senate, but in legislative circles at the Capitol it is well understood that the question of foreign affairs relating to the Peace Treaty and League of Nations will have an important effect upon the early passage of any legislation.

England is preparing to provide herself with cheap and abundant electricity for heating, lighting and manufacturing purposes at an initial cost of approximately $100,000,000. The plan, which is now before Parliament, provides for placing the country on an electrical basis. Water-power is to be extensively used.

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*From the report of the Prime Movers Committee of the National Electric Light Association, 1919.

Methods of Increasing Boiler-Room Efficiency[*]

By D. S. JACOBUS
Advisory Engineer, Babcock and Wilcox Company

MY REMARKS will be limited to that part of the general problem of fuel saving that is met in the boiler room. More is often to be lost or gained in the operation of the boiler room than in any other part of a power plant. To secure efficiency and capacity we all know that the following features must be watched after: The surfaces of the boiler must be clean inside and out and the gas passages and flues must be free and unrestricted from the deposit of soot or ashes; the baffles and settings must be reasonably free from leakage; the fuel must be properly fired.

To secure the best efficiency, the fuel or any combustible elements distilled from the fuel must be completely burned within the furnace chamber. Again, the combustion must be such that the gases that pass from the furnace are uniform in composition; that is, some of the gases must not contain a considerable amount of excess air and others possibly a deficiency of air, thus leading to what is termed a laneing action. If the gases are burned entirely within the furnace chamber, the entire surface of the boiler is effective in absorbing heat. If there is secondary combustion between the boiler tubes, which may occur to a considerable extent if there is a laneing action in the gases and may possibly extend entirely through the setting, all of the boiler surface is not effective after combustion is complete, with the result that there is an increase in the temperature of the flue gases over what it would be should the gases be burned within the furnace, and a corresponding loss of efficiency. Again, in some instances there is a loss through combustible elements, such as carbon monoxide, passing off in the flue gases. Another loss that is experienced in coal burning is through the unconsumed fuel in the ashes, often due to poor operation.

Fireman Should Be Provided with Proper Instruments

It is a mistake not to provide proper instruments to guide the firemen. A general impression prevails that test results are one thing and operating results another, and that the operating results necessarily fall considerably below the test results. Operating results do as a rule fall considerably below the test results, but there is no reason why this should be so in the great majority of cases.

It is often assumed that the average flue-gas analysis combined with the percentage of carbon in the ash is a measure of the efficiency of a furnace, and that if these features are known the boiler man should be able to guarantee the boiler efficiency. Such is not the case, as a great deal depends on whether all of the combustion is or is not completed within the furnace chamber. If there is delayed combustion between the tubes of the boiler, it will have an influence on the flue-gas temperature and efficiency, and it can readily be appreciated that if two plants are operating with the same average flue-gas analysis and percentage of carbon in the ash, and in one of the plants there is secondary combustion between the tubes and in the other there is not, the plant where all of the combustion is completed in the furnace will have the highest efficiency.

Often great stress is laid on carrying a high percentage of CO_2 irrespective of the other operating conditions, and in certain instances the firemen are paid bonuses based on the percentage of CO_2. If all the other conditions of operation are watched after, this system will give good results; but if the carrying of a high percentage of CO_2 is made the sole aim of the firemen, there may be wastes in other directions that will counterbalance any gain through minimizing the amount of excess air.

Where a high percentage of CO_2 is carried, it is often found that CO will be present. In some installations it is impossible to carry more than a certain percentage, say 13 per cent., of CO_2 before having a material amount of CO. An analysis with coal firing which indicates 13 per cent. of CO_2 and no CO is more favorable from a heat-loss standpoint than one that gives 15 per cent. of CO_2 and ½ per cent. of CO. As the carrying of a high percentage of CO_2 is apt to lead to secondary combustion between the boiler tubes, thereby involving an additional loss through increasing the temperature of the flue gases, it can readily be seen that it is often a mistake to aim for too high a percentage of CO_2. How high a percentage should be aimed for depends upon the form of furnace and the furnace volume. Ordinarily, with coal it does not pay to exceed about 13½ per cent.

The Hempel type apparatus, where the gases are shaken up with the solutions, is, as a rule, more reliable in indicating the amount of CO than the Orsat, and in accurate work it is well to check the Orsat apparatus against the Hempel.

Clean Feed Water Is Essential

The use of impure feed water is entirely too prevalent. This naturally leads to a loss in efficiency through incrusting the inner part of the heating surface and through making it necessary to blow down the boilers an undue amount. There is an added loss through having to cut out the boilers a large part of the time for cleaning and for replacing leaky tubes. Greater attention is now being given to securing clean feed water, especially in the larger plants. In many instances it pays to install evaporating apparatus for supplying the makeup water. Naturally, this can be done only where surface condensers are used, but where it can be done good results are bound to follow.

A considerable loss in plant efficiency in coal firing often comes through the carrying of banked fires. There is a corresponding loss in burning other fuels, and the operation of a given plant may cause this element to greatly affect the results secured. As an instance, in one particular case where I was active in securing the best results, the economy of an oil-burning plant was raised over 25 per cent. simply through operation and by going over the plant to eliminate heat losses through drips, etc. In oil-burning plants a mistake is often made in keeping the steam pressure as steady as possible by changing the firing conditions one way and the other to such an extent that it is impossible to maintain the best furnace efficiency. The best results are secured by feeding the oil to the burners at a reasonably uniform rate, varying the oil pressure one way and the other slowly to meet the demands of the power, even though this may result in a less steady steam line than would be secured through jumping the oil pressure one way and the other to maintain a practically constant steam pressure. A recording pressure gage placed on the oil line where the steam pressure is maintained at a constant figure will often give illuminating results in indicating a broad band with the oil pressure varying 200 or 300 per cent. one way and the other, whereas for best operation the oil pressure will be represented by a reasonably steady line which will follow in a general way the power requirements. A good guide for efficient operation in running with oil fuel is the amount of superheat obtained, which should be about uniform in all the boilers. If the superheat in a boiler becomes high, it is due either to running the boiler harder than the others or to excess air, either of which conditions should be corrected to obtain the best results.

Another good guide in oil burning is to observe the appearance of the gases as they pass through the setting. If the gases are clear, it indicates excess air, and if too smoky, an insufficient air supply. For the best results there should be a slight haze throughout the gases. The appearance of the gases leaving the stack is also a good guide, as too clear a stack indicates excess air, whereas a smoking stack shows insufficient air in one or more of the boilers, the best conditions being indicated by a slight haze.

It is feasible to set a figure for efficiency higher than that which would ordinarily be secured and to pay the operating crew a certain bonus based on the increase in efficiency above this figure. In this connection, Edward N. Trump has said the following:

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[*] From a paper before the American Boiler Manufacturers' Association, Buffalo, N. Y.

> If you give a bonus to the firemen, you will be sure to have some improvement in efficiency. I have found at least 10 per cent. saving by paying bonuses to the firemen, sometimes by working one shift against the other. Competition encourages them to work harder, to increase the saving.

Mr. Trump has secured record efficiencies in the plants of his company. With boilers of about 300 hp., fitted with economizers, run at from 100 to 120 per cent. of rating, he has secured plant sufficiencies, measured by the monthly operation, of 85 per cent. In his boiler plants with very large units he has obtained a corresponding efficiency of 88 per cent. The load on the boilers in Mr. Trump's plants is nearly uniform and does not vary to the extent that it does in the average electrical-power generating station.

For a long time there were many instances where the use of the older type of waste-heat boilers would not lead to a good return on the investment. Since developing our modern type where the boilers have a considerably higher draft resistance than in the older type and where this draft resistance is overcome through the use of an induced-draft fan, we have installed over 100,000 hp. of such boilers in connection with openhearth furnaces alone, and the steam generated by these boilers represents a saving in the neighborhood of 1,000,000 tons of coal per year. This is only one of the fields where waste-heat boilers may be applied to advantage, and it shows the magnitude of the savings that can be effected.

FURNACE DESIGN AND STOKER DESIGN

Furnace design cannot be divorced from stoker design when the best obtainable results are aimed for. After designing the stoker, the next feature bearing on economy is the disposition of the surface of the boiler. With a given boiler arrangement, tube spacing, etc., it usually follows that to secure a high heat transfer the draft resistance will be greater than with the same amount of surface arranged and provided with baffles that will give a lower rate of heat transfer. If the arrangement of heating surface and baffles is such as to lead to too high a draft resistance, the capacity developed by the boiler with a given draft may be lower than desired. If the arrangement is such as to give a low draft resistance, the efficiency may be less than it should be. In providing a proper design, one of these features must be balanced against the other and an arrangement provided which will give the best all-round results.

The addition of an economizer will increase the economy, say, 5 to 10 per cent. Now that the price of fuel is increasing everywhere, a greater number of economizers are being installed.

For large plants the efficiency obtainable with a modern steam-boiler and steam-turbine installation is greater than could be secured through gasifying the coal in producers and using the gas in gas engines. A large steam-turbine plant of the best modern design will generate a kilowatt-hour with a heat consumption based on the heat in the fuel of 17,000 B.t.u. per kw.-hr. This as a round figure for plants of the best modern construction with a load factor of, say, 60 per cent. and steam pressures of from 250 to 300 pounds.

By increasing the steam pressure and raising the superheat, the figure can no doubt be reduced to the neighborhood of 15,000 B.t.u. per kilowatt-hour. There is no likelihood of the gas engine displacing the steam turbine for large power generating station work for some time to come.

The Pacific Gas and Electric Co. of San Francisco has purchased all the properties of the Northern California Power Co., at a price said to be $10,000,000. The purchase, it is said in financial circles, is the direct result of coöperative work carried on by the two companies during the war. Properties of the Northern California Power Co. extend from Sacramento to the northern state boundary.

Bearing Metals*

The essential characteristic of all bearing alloys is a structure made up of alternately hard and relatively soft microscopic particles intimately mixed. The function of the hard particles, or bearing crystals, is to support the load and resist the wear. These bearing crystals should not be hard enough to prove distinctly abrasive to the journal surface. General experience shows that an extreme hardness of the bearing crystals is characterized by an excessive wear of the journal. The function of the softer or more readily abraded crystals is that of being plastic and permitting the bearing crystals to adjust themselves to surface requirements of the journal. These softer crystals are also more readily abraded, and therefore wear slighly below the surface of the bearing crystals and thus form upon the bearing surface slight depressions which serve for the retention of the lubricant. However infinitesimal in amount this may seem, nevertheless it is this lubricant that prevents scoring or seizing when the journal is starting up from rest at a time when actual metallic contact between the bearing surfaces exists. The same is equally true under an excessive load. This function of retaining a slight quantity of the lubricant upon the bearing surfaces when metallic contact exists, characterizes a bearing alloy in its truest sense. Therefore a bearing metal may be defined as an alloy that is capable of retaining a lubricant on a bearing surface.

A matter of importance, which seems not to have been considered heretofore, is the fusing temperature of the bearing crystals. From observations made it is evident that under severe conditions where relatively low-fusing bearing crystals exist in a high-fusing alloy, these bearing crystals actually fuse on their surfaces during the process of the "running in" of the bearing. The delta copper-tin crystal (Cu_4Sn) may be cited as a particular example, and in some severe conditions corresponding to automotive worm-drive service the alpha copper-phosphorus crystal (Cu_3P) seems to function in a similar manner. It is doubtful whether these conditions ever obtain in any of the babbitts, since their bearing crystals are the highest-fusing compounds of these alloys.

The study of bearing metals is very incomplete unless these alloys are considered in conjunction with the other corresponding bearing member. The extreme variety of modern steels makes this necessary, since a bearing alloy suited for a soft low-carbon machine-steel journal would not be an economic selection for a high-carbon nickel-chrome heat-treated journal, and a most economic selection for the latter would prove destructive to the former.

It seems exceedingly improbable that laboratory accelerated service tests can ever give general satisfaction, owing to the difficulty of reproducing in a few hours' time the equivalent of many years of service conditions. It is our conviction that much more can be learned from the study of failures, and also in studying old bearings together with their journals, which have given eminently satisfactory service for an exceptionally long period.

Proposed Relay Nomenclature

The Committee on Protective Devices of the American Institute of Electrical Engineers, in making an analysis of the transmission-line protective-relay situation throughout this country, found that the relay nomenclature used by the different operating and manufacturing companies for the various classes of relays was not in harmony. The committee therefore undertook the work of standardizing this nomenclature, and the following has been proposed and was given in a paper, "Transmission-Line Relay Protection," by H. R. Woodrow, D. W. Roper, O. C. Traver and P. MacGahan, presented at the 35th annual convention of the A. I. E. E., June 24 to 27, 1919:

Electric-Protective Relay—An intermediate device by means of which one circuit is indirectly controlled by a change in conditions in the same or other circuits. The relay is ordinarily equipped with contacts to open or close an auxiliary circuit.

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*From report of Sub-Committee on Bearing Metals, Spring meeting, American Society of Mechanical Engineers, Detroit, Mich., June 16-17, 1919.

Directional Relay—Any relay which functions in conformance with direction of power or voltage or current or phase rotation, etc.

Power-Directional Relay—Any relay which functions in conformance with direction of power.

NOTE. This includes both uni-directional relays with single-throw contacts and duo-directional relays with double-throw contacts. The reason this name is preferred to "reverse power" is that the device is frequently used to function under normal direction of power. Furthermore, in some cases the normal condition of the system may permit power to flow in either direction. Relays for use in either alternating or direct-current circuits are to be classed as power-directional relays.

Polarity-Directional Relay—Any relay which functions by reason of a reversal of the normal direction of polarity.

Phase-Rotation Relay—Any relay which functions by reason of a reversal of the normal direction of phase rotation.

Current Relay—Any relay which functions at a predetermined value of the current. These may be either overcurrent relays or undercurrent relays.

Voltage Relay—Any relay which functions at a predetermined value of the voltage. These may be either overvoltage relays or undervoltage relays.

Watt Relay—Any relay which functions at predetermined value of the watts. These may be either overwatt relays or underwatt relays.

Frequency Relay—Any relay which functions at a predetermined value of the frequency. These may be either overfrequency relays or under-frequency relays.

Temperature Relay—Any relay which functions at a predetermined temperature in the apparatus protected.

Open-Phase Relay—Any relay which functions by reason of the opening of one phase of a polyphase circuit.

Differential Relay—Any relay which functions by reason of the difference between two quantities such as current or voltage, etc.

NOTE. This term includes relays heretofore known as "ratio balance relays," "biased" and "percentage differential relays."

Locking Relay—Any relay which renders some other relay or other device inoperative under predetermined values of current or voltage, etc.

Trip-Free Relay—Any relay which prevents holding in an electrically operated device such as a circuit-breaker while an abnormal condition exists on the circuit.

Auxiliary Relay—Any relay which assists another relay in the performance of its function and which operates in response to the opening or closing of its operating circuit.

Signal Relay—An auxiliary relay which operates an audible or a visible signal.

QUALIFYING TERMS AS APPLIED TO RELAYS

Notching—A qualifying term applied to any relay indicating that a number of separate impulses are required to complete operation.

Inverse Time—A qualifying term applied to any relay indicating that there is purposely introduced a delayed action, which delay decreases as the operating force increases.

Definite Time—A qualifying term applied to any relay indicating that there is purposely introduced a delayed action, which delay remains substantially constant regardless of the magnitude of the operating force. (For forces slightly above the minimum operating value the delay may be inverse.)

Instantaneous—A qualifying term applied to any relay indicating that no delayed action is purposely introduced.

Where relays operate in response to changes in more than one condition, all functions should be mentioned.

The Protective Device Committee expresses the desire that the foregoing nomenclature be adopted by all parties so that any particular class of relays will be given a definite name.

Jobs for marine engineers, paying $143.75 a month for third assistants to $287.50 a month for chiefs, with board and quarters free, are actually going begging at Atlantic ports, according to a statement issued by the United States Shipping Board. The situation is acute. Vessels are tied up in many of the larger ports waiting for engineers. There are now 500 engineers in training at special schools, but these are not yet available.

Method of Turning On Steam in Large Lines*

Accidents and consequent losses, both direct and indirect, due to the failure of steam piping and fittings while being cut into service when steam is being turned in, have apparently all been due to expansion strains rather than pressure strains. The expansion strains which caused the damage were usually different from those which were present after the line had been heated to full temperature.

A further analysis discloses the fact that the particular form of expansion causing the trouble has been in most cases due to the presence of air in the steam line at the time steam was being turned on. Air, having approximately twice the density of steam, remains at the bottom of the pipe and prevents the steam from coming in contact with (and thereby expanding) parts of the piping. On a straight run of horizontal piping the result is a tendency to "rainbow" the piping. This has been proved by actual test. The further result of this action is to put a heavy compression strain on the upper half of all joints and fittings and a corresponding tensile strain on the lower half. This trouble is experienced to a greater extent with large than with small piping. This may be due either to the pipe being so small that the air and steam do not remain stratified, or possibly to the great flexibility of the small piping.

The method of turning on steam, which will prevent trouble of this kind, is as follows:

All the drains and air vents on the line are opened. Steam is turned into the line very rapidly, the valve being opened one-fourth to one-half its full opening. This applies not only to low pressure, but to high pressure as well. This procedure results in driving the air out of the line very rapidly and allows the pipe to heat uniformly. To engineers who have been accustomed to "warming up" slowly, or "soaking" the line, this method will no doubt seem dangerous, but the results obtained from close observation and actual test indicate that it is the best that can be followed.

The same phenomena take place in starting up a steam turbine. In the Parsons type of machine where the blade and clearances are small, the "warming up" method of starting is likely to cause blade failures, because when a machine is standing still, the spindle and cylinder "rainbow" in the same direction, but as soon as the spindle revolves one-half a revolution, the top of the spindle (then at the bottom), unless the clearances are large, rubs the bottom of the cylinder. The new method is to open the throttle quickly until the spindle starts to revolve, after which the throttle is almost closed again, allowing the turbine to revolve slowly until the heat is evenly distributed.

The United States Shipping Board Emergency Fleet Corporation has arranged for the sale of its surplus and salvage property. Complete manufacturing plants, entire shipyards, dry docks, ships, complete or half built, and any article down to scrap metal are among the items to be disposed of by public sale. To sell to the market, and not to break the market, is the Government policy in disposal sales to be held by all its departments and branches. Upon the sales list are marine railways, housing and transportation projects, numerous allotments of machinery, equipment and supplies, including wood-working machinery, machine tools and fixtures, electrical machinery, boiler- and forge-shop equipment, marine equipment and accessories, air-compressor equipment, contractors' equipment and supplies, bridge and gantry cranes, steel plates, shapes, and bars, pumping machinery, scrap metals, lumber, deck equipment, galley equipment, hospital and commissary supplies and the like. All sales will be consummated either by open bidding on advertised items or from price lists made up after careful study of existing market conditions and approved by the Sales Review Board.

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*From report of Educational Committee, National District Heating Association.

New Publications

LIQUID FUELS FOR INTERNAL-COMBUSTION ENGINES. By Harold Moore. Published by D. Van Nostrand Co., New York; Cloth; 6 x 8½ in., 200 pages; illustrated. Price, $5.

The advances made in the design and application of internal-combustion engines makes a book of this kind desirable. The author does not pretend to give an exhaustive explanation of the chemistry of the compounds present in liquid fuels and the reactions involved in their preparation and purification. The book deals chiefly with the procedure necessary for the examination and valuation of liquid fuels for use in engines. The fuels considered are petroleum, shale oil, coal tars, lignite tars, products of the carbonization of wood and peat, animal and vegetable oils, and alcohol. Considerable space is given to fuels for engines fitted with carburetors, vaporizers and atomizers. Calorimetry is the subject of the last chapter. The appendix is made up of much valuable tabular data, as those on spontaneous ignition of various oils and their products, composition of coal tar, calorific properties of various combustibles, limits for downward propagation of flame (air and fuel mixture), oil specifications, a glossary, etc. The volume is well illustrated, though not exceptionally profusely, and it contains considerable tabular matter. Considering these, the price seems high. However, those who feel the need for such a work, will likely be glad to pay it.

Personals

Richard Burroughs, formerly in the engineering department of the Hotel Strand, is now chief engineer of the new Hotel Ambassador, Atlantic City, N. J.

John H. O'Neil, who served with the 38th Engineers in France, has returned to his old position as first assistant engineer with the Blackstone Gas and Electric Co., Pawtucket, R. I.

Miscellaneous News

Shipping Board Needs 1500 Firemen—The United States Shipping Board has announced that it has vacancies for 1500 firemen in the merchant marine. The age limit is from 18 to 35 years; minimum weight 140 lb. The pay of the marine firemen is $75 a month, with board and quarters free.

College Courses in Shipbuilding—Schools of naval architecture and ship construction may soon become important branches of educational institutions of the United States if this nation continues its headway in maritime strength. Fourteen universities and technical colleges have signified their interest in a line of instruction that was decadent almost to the point of extinction when the needs of war presented a demand for ships that could not be denied, and some of them have already established courses in naval architecture, marine engineering and ship construction, while others are planning similar action. The United States Shipping Board Emergency Fleet Corporation, which felt so keenly the lack of technicians in carrying out its shipbuilding program, and had to establish emergency schools for intensive training, is encouraging and fostering plans for the new schools in all institutions capable of expanding their fields of learning. It has furnished to those interested valuable data gained through experience with all phases of the shipbuilding industry in every quarter of the country, and stands ready to give similar aid to all who may apply. Men in closest touch with the situation say that the need for marine architects and engineers will grow as the yards expand and enter the open field of competition in construction for home and foreign account.

Business Items

Plant Engineering and Equipment Co., Inc., has opened branch offices in Kansas City, Mo., 312 Elmhurst Building; Salt Lake City, Utah, 17 Exchange Place, and Charlotte, N. C., 815 Independence Building.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7 80@7 95
Stove	7 95@8 15
Chestnut	8.05@8 35

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2 15@2.75	$2 75@3.25
Philadelphia, gross tons	4 27@4.95	5.95@5 50
New York, gross tons	4 62@5.29	5 29@5 85
Alongside Boston (water coal), gross tons	6.10@6.85	6.90@7.55

Pocahontas and New River are quoted at $4·70 @5.25 f.o.b. Norfolk and Newport News, Va., for spot coal, and $7.20@8.60 alongside Boston, these prices being on a gross ton basis.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Company Circular		Mine	Company Circular
Broken	$6 05	$7 90	Pea	4 90	6.65
Egg	5.95	7 80	Buckwheat	3 40	5.15
Stove	6 20	8.05	Rice	2 75	4 50
Chestnut	6.30	8.15	Barley	2.25	4.00

Bituminous

	Spot	Contract
South Forks	$2.90 @ $3 25	$2 95 @ $3 50
Cambria County (good grades)	2 75 @ 2 95	2 95 @ 3 25
Clearfield County	2.50 @ 2 75	2.80 @ 2.95
Reynoldsville	2.50 @ 2 75	2 75 @ 2 95
Quemahoning	2 65 @ 2.85	2.95 @ 3 10
Somerset County (best grades)	2 50 @ 2.75	2.95 @ 3.10
Somerset County (poorer grades)	2.00 @ 2 35	2.50 @ 2 75
Western Maryland	2.25 @ 2 50	2.50 @ 2 75
Fairmont	2.00 @ 2 25	2 35 @ 2 50
Latrobe	2.10 @ 2.25	2 25 @ 2.40
Greensburg	2 25 @ 2 35	2 35 @ 2.60
Westmoreland	2 60 @ 2.75	2 60 @ 2 75
Westmoreland run-of-mine	2.35 @ 2.60	2.35 @ 2.65

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide		Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4 45
Egg	6 05	7 90	Rice	2 75	3 65
Stove	6 30	8 15	Boiler	2.50	3 50
Nut	6 40	8 25	Barley	2.25	3.15
Pea	5 00	6 60	Culm	1 25	2.15

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3 25
Mine-run	2 35@2 50	3 00
Screenings	1.85@2 20	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2 45	$2 75	$2 40
Black Creek and Cahaba	3.45	3 75	3.05
Jagger - Pratt Corona	2.85	3.05	2.45
Blacksmith		5.25	

Domestic quotations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3.95@$4 60
Corona	3 50
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

	Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes, lump, egg, Nos. 1 and 2 nut	$2 75		
Williamson County			
Prepared sizes, lump, egg, nut	$2.55	$2 55	$2 00@2 75
Mine-run	2.35	2 20	1.60@1.75
Screenings	2.20	2.05	1.15@1.30
3-in. lump		2.30	
2-in. lump			1.75@1.90

Williamson-Franklin rate to St Louis is $1.07; other rates 92½c.

New Construction

PROPOSED WORK

Mass., New Bedford—The National Sponge Silk Co., c/o Lockwood-Greene Co., Arch., 101 Park Ave., New York City, will install a steam heating system in the 4-story, 120 x 400 ft. factory which it plans to build. Total estimated cost, $750,000.

N. Y., Brooklyn—The Long Island Amusement Co., Garden Theatre, Jamaica, will install a steam heating system in the 1 story, 130 x 140 ft. theatre which it plans to build on Fulton St., near Church Ave., here. Total estimated cost, $400,000. G. Mausert, Pres., R. T. Short, 370 Macon St., Arch.

N. Y., Brooklyn—The Gibbons Co., 316 Columbia St., will install a steam heating system in the 5 story, 125 x 175 ft. office building which it plans to build on Columbia St. and Hamilton Ave. Total estimated cost, $250,000.

N. Y., Brooklyn—Mason Au Mangenheimer, 22 Henry St., will install a steam heating system in the 8 story, 60 x 100 ft. factory which it plans to build at 24 Henry St. Total estimated cost, $150,000. Ebling & Magnerson, 52 Vanderbilt St., New York City, Arch.

N. Y., Brooklyn—C. Hutwelke, 655 5th Ave., will install a steam heating system in the 5 story, 63 x 100 ft. packing house which he plans to build on Hall St., near Flushing Ave. Total estimated cost, $100,000. E. F. Seelye, 101 Park Ave., New York City, Engr.

N. Y., Long Island City—L. Gold, 44 Court St., Brooklyn, will install a steam heating system in the 2 story, 75 x 190 ft. garage which he plans to build on William St., near North James St. Total estimated cost, $110,000. F. S. Parker, 44 Court St., Brooklyn, Engr.

N. Y., Long Island City—J. Simons Co., 350 Broadway, New York City, will install a steam heating system in the blacksmith shop and garage which it plans to build on Nelson Ave. Total estimated cost, $100,000. Westinghouse, Church & Kerr, 37 Wall St., New York City, Engr.

N. Y., New York—W. J. Wilgin, 165 Broadway, will install a steam heating system in the 1 story, 75 x 100 ft. garage which he plans to build at 149th St. and Park Ave. Total estimated cost, $155,000. A. Fellheimer, 7 East 42nd St., Arch.

N. Y., New York—Street & Smith, 161 West 15th St., will install a steam heating system in the 7 story, 50 x 100 ft. addition which it plans to build to its publishing house. Total estimated cost, $125,000 H. O. Chapman, 334 5th Ave., Arch.

N. Y., New York—A. Lewisohn, 61 Broadway, will install a steam heating system in the 1 story, 83 x 176 ft. theatre which it plans to build at 4023 Broadway. Total estimated cost, $120,000. G. M. Pollard, 347 5th Ave., Engr.

N. Y., New York—The C. Hensel Realty Co., 3879 10th Ave., will install a steam heating system in the 2 story theatre, store and office building which it plans to construct on Dyckman St., between Nagle and Post Ave. Total estimated cost, $300,000. Moore & Landseidel, 148th St. and 3rd Ave., Arch.

N. Y., New York—The Butterick Publishing Co., Spring and Varick St., will install a steam heating system in the 9 story addition which it will construct to its loft building. Total estimated cost, $1,200,000. Ballinger & Perrott, 47 West 34th St., Archt. and Engr.

N. Y., New York—The Metropolitan Life Insurance Co., Madison Ave., will install a steam heating system in the 16 story, 75 x 150 ft. auditorium and office building which it plans to build at 11-15 Madison Ave Total estimated cost, $800,000. D. E. Ward, 1 Madison Ave., Engr.

N. Y., New York—G Backer Construction Co., 11 East 55th St., will install a steam heating system in the 1 story, 50 x 100 ft mercantile building which it plans to build at 16-18 West 36th St. Total estimated cost, $225,000. Sommerfield & Steckler, 31 Union Sq., Arch.

N. Y., New York—The Fifth Ave. Baptist Church, 8 West 46th St., will install a steam heating system in the 3 story, 80 x 98 ft., church which it plans to build at 64th St. and Park Ave. H. C. Pelton & Allen & Collens, 35 West 39th St., Engr.

N. Y., New York—The Krims Realty Co., 426 West 14th St., will install a steam heating system in the 3 story, 25 x 100 ft. store and office building which it plans to build at 143 West 33rd St. Total estimated cost, $100,000. M. Krim, Pres. M. S. Schwartz, 309 Bway., Arch.

N. Y., Yonkers—The Federal Sugar Refining Co., 91 Wall St., New York City, will install a steam heating system in the warehouse which it plans to build here. Total estimated cost, $200,000. Westinghouse, Church, Kerr & Co., 37 Wall St., New York City, Engr.

N. J., New Brunswick—The Victory Amusement Corp. will install a steam heating system in the 100 x 100 ft. theatre which it plans to build on Albany and Washington St. Total estimated cost, $300,000. J. H. Scheier, 25 West 42nd St., New York City, Arch.

Penn., Grove City—The Municipal Electric Power Co. plans to build a new power plant and equip same with machinery. Estimated cost, $75,000.

Penn., Philadelphia—The Beth Salem congregation, 224 Market St., will install a heating system in the 3 story, 100 x 125 ft. synagogue which it plans to build. Total estimated cost, $100,000. Fieldstein & Rothchilds, 1238 Chestnut St., Arch.

Penn., Philadelphia—The Vigogne Mills, Unity and Oakland St., will install a steam heating system, boilers and engines, in the 3 story, 65 x 250 ft. mill which it plans to build. M. Ward Easby, 1420 Chestnut St., Arch.

Penn., Philadelphia—J. C. Kahn, Morris Bldg., will install a steam heating system in the 7 story, 101 x 150 ft. loft building which he plans to build. Total estimated cost, $300,000. Le Roy B. Rothchild, 1225 Morris Bldg., Arch.

Md., Baltimore—W. Schluderberg & Son, 4th and Bank St., will install a steam heating system and refrigerators in the 4 or 5 story meat packing plant which they plan to build on East Baltimore St., between 5th and 7th St. Total estimated cost, $250,000. C. B. Comstock, 110 West 40th St., New York City, Engr.

Md., Baltimore—St. Mary's Industrial School, Wilkins Ave., will install a vapor heating system in the 4 story, 63 x 113 ft. dormitory and swimming pool which it plans to build. Total estimated cost, $200,000. H. I. Kavanaugh, 913 North Charles St., Arch.

Md., Baltimore—The Luther Memorial Lutheran Church, 345 Ilchester Ave., will install a steam heating system in the 2 story, 75 x 150 ft. church which it plans to build on Guildford Terrace and University Parkway. Total estimated cost, $100,000. John Freund, 11 East Lexington St., Arch.

S. C., Clinton—The Board of Regents of the State Hospital for Insane, Columbia, will install two steam heating plants in connection with the construction of two 1 and 2 story dormitories for the School for Feeble Minded, about ½ mi. from here. R. G. Scarborough, Chn. G. E. Lafaye, 1003 Loan & Exchange Bank Bldg., Columbia, Arch.

S. C., York—The School Board will install a heating plant and modern ventilating system in the 2 story, 100 x 150 ft. high school which it plans to build. Total estimated cost $100,000. S. McDow, Chn. C. Wilson, 808 Palmetto Bldg., Columbia, Arch.

La., New Orleans—The Charity Hospital, Tulane Ave., plans to build a 2 story power house. Estimated cost, $90,000. A. W. Lewin, Weis Bldg., Engr.

Ohio, Cleveland—The Arjo Realty Co., 214 Williamson Bldg., plans to build an addition to its factory at 6545 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $250,000.

Ohio, Cleveland—The Cuyahoga County Memorial Association, Court House, will install a steam heating system in the 5 story, 150 x 200 ft. hospital which it plans to build on West 4th St. and Fairchild Ave. Total estimated cost, $300,000. W. S. Lougee, 500 Marshall Bldg., Arch.

Ohio, Cleveland—The Euclid Chester Co., Guardian Bldg., will install a steam heating system in the 2 story, 100 x 112 ft. warehouse which it plans to build at 2900 Chester Ave. Total estimated cost, $100,000.

Ohio, Cleveland—The Pilgrim congregation, West 14th St. and Starkweather Ave., will install a steam heating system in the 5 story, 100 x 200 ft. clubhouse which it plans to build. Total estimated cost, $100,000. D. F. Bradley, pastor.

Ohio, Cleveland—The Sixth City Realty Co., Guardian Bldg., will install a steam heating system in the 167 x 370 ft. garage which it plans to build on East 6th St. and St. Clair Ave. Total estimated cost, $1,300,000.

Ohio, Cleveland—The United Motors Service Co., East 40th St. and Prospect Ave., will install a steam heating system in the 2 story, 100 x 200 ft. sales and service building which it plans to build. Total estimated cost, $200,000.

Ohio, Piqua—The J. J. Wernette Engineering Co., 441 Houseman Bldg., Grand Rapids, is receiving bids for a 475 k.v.a., 80 per cent power factor, 240 volt, 3 phase, 60 cycle generator, for the French Oil Mill Machinery Co., here.

Mich., Detroit—The Public Welfare Commission, City Service Bldg., will install a steam heating system in the 4 story, 50 x 87 x 216 ft. hospital which it plans to build on St. Antoine and Macomb St. Total estimated cost, $420,000. J. Scott & Co., 2326 Dime Bank Bldg., Arch.

Mich., Flint—St. Mathew's Parish will install a steam heating system in the 1 story church which it plans to build on Beach St. Total estimated cost, $150,000. Van Leyden, Schilling & Keough, 1115 Union Trust Bldg., Detroit, Engr.

Mich., Hamtramck (Detroit P. O.)—The Board of Education, 50 Broadway, Detroit, will install a steam heating system in the 2 story, 127 x 104 ft. school which it plans to build on Carpenter and McDougall Ave. Malcolmson & Higginbotham, 404 Moffat Bldg., Detroit, Arch.

Mich., Wahjameja—The Michigan Colony for Epileptics will install a steam heating system, including a pump and ash hoist, in the 1 story, 43 x 265 ft. hospital which it plans to build. E. R. Dunlop, 709 Hammond Bldg., Detroit, Arch.

Wis., Sheboygan—The Commercial Engraving Co., 101 North 8th St., will install a steam heating system in the 3 story, 60 x 170 ft. engraving and printing plant which it plans to build on 8th St. Estimated cost, $150,000.

Kan., Salina—The Planters Hotel Co. will install a steam heating system in the 4 story, 100 x 120 ft. hotel which it plans to build. Total estimated cost, $150,000. C. W. Shaver, Arch.

Kan., Stockton—Rooks County will install a steam heating system in the 3 story, 80 x 100 ft. court house which it plans to build. Total estimated cost, $200,000. F. C. Squires, Topeka, Kan., Arch.

Minn., Duluth—The West Duluth Y. M. C. A., North Central Ave., will install a steam heating system in the 3 story, 80 x 135 ft. building which it plans to construct. Total estimated cost, $100,000. Zirman & Jenssen, Exchange Bldg., Engr.

Mo., Kansas City—The National Cloak & Suit Co., 207 West 24th St., New York City, N. Y., will install a steam heating plant in the 12 story factory which it plans to build here. Total estimated cost, $2,500,000. N. M. Dunning, 310 South Wabash Ave., Chicago, Ill., Engr.

Okla., Oklahoma—The Tradesman's State Bank, 105 West Main St., will install washed air, heating and ventilating systems in the 10 story, 60 x 90 ft. bank which it plans to build on Main and Broad St. Total estimated cost, $300,000. Hawk & Parr, 501 Security Bldg., Arch.

Idaho, Boise—Tourtellota-Hummell Co., Overland Bldg., Boise, will install a steam heating system in the 4 story, 100 x 122 ft. Y. M. C. A. building which it plans to construct. Total estimated cost, $125,000.

Cal., Eagle Rock—Bids will be received until July 21, by B. B. Martsoff, City Clk., for furnishing a deep well turbine pump of centrifugal runner type, to have a capacity of 350 gal. per minute on 125 ft. lift.

Que., Montreal—The Provincial Government, Quebec City, will install a steam heating system in the 5 story, 100 x 150 ft. court house which it plans to build on Notre Dame St., E., here. Total estimated cost, $100,000. Dept. of Pub. Wks., Quebec City, Engr.

Que., Montreal—Bids will be received until July 21, by L. R. Thompson, Secy. and Engr., Lignite Utilization Board of Canada, 80 St. Francis Xavier St., for furnishing three, 125 hp. horizontal return tubular boilers with fittings for 150 lb. pressure, suitable for suspension setting; 1 steam driven boiler feed pump, suitable for above boilers, two 200 k.v.a., 550 v., 3 phase, 60 cycle, gasoline or oil driven emergency lighting set; 1 standard underwriters' steam fire pump, having a capacity of 1000 gal. per minute, 150 lb. steam pressure.

Ont., Walker—The General Motors Corp., Boyer Bldg., Detroit, Mich., is in the market for about 425 motors, including 100 five hp. and 150 three hp. motors, for its plant here.

CONTRACTS AWARDED

N. Y., New York—B. S. Moss, 729 7th Ave., has awarded the contract for the construction of a 2 story, 125 x 150 ft. theatre which he plans to build at 161st St. and Prospect Ave., to the Fleischman Construction Co., 531 7th Ave. A steam heating system will be installed in same. Total estimated cost, $600,000.

Ohio, Cleveland—The city has awarded the contract for installing a steam heating system in the 2 story, 70 x 76 ft. bathhouse and gymnasium which it plans to build at East 26th and Central St., to the Chafer Co., 431 Champlain Ave.

Ohio, Cleveland—The Grabler Manufacturing Co., 6565 Broadway Ave., has awarded the contract for the construction of a 4 story, 90 x 100 ft .addition to its factory, to S. W. Emerson Co., 1900 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—The McKinney Steel Co., 4002 Dille Rd., will build a 2 story, 32 x 50 ft. pump house by day labor. Estimated cost, $10,000.

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See pages 89 to 98 this issue

POWER

Volume 50 New York, July 22, 1919 *Number* 4

THE UNCHARTED SEA of ENGINEERING RESEARCH
D.E. WHALEY
POWER

Wanted: Navigators

The New Madison Water Works

Building a new plant over an old one while maintaining the service. A choice of artesian or lake water and comparative costs. Air-lift system supplants motor-driven pumps in individual wells.

IN THE year 1914 in Madison, Wis., it was realized that the city pumping station had become inadequate to meet the growing demands entailed by the increase in population. A new or at least a remodeled station was necessary, and it was an open question whether to continue using artesian well water or to draw on Lake Mendota and insure a supply adequate to meet all future demands. The engineering problems involved and their solution are interesting, but to appreciate the new work, a brief résumé of the development of the pumping system will be needed as a background.

The original water-works system of the city was constructed in 1882, when the population was 10,384. It included slightly over 11 miles of mains costing $1.62 per foot or a trifle more than $8553.60 a mile. The building was located 2000 ft. north of the State Capitol in what is now a residential district. In 1900 it was enlarged and consisted of a one-story brick structure divided into pumproom, boiler room, and coalhouse. The first pumping engines installed were one 1,500,000-gal. and one 2,500,000-gal. unit, each consisting of a single-cylinder noncondensing Corliss engine geared to a duplex double-acting pump. In 1902 these units were supplemented by a vertical triple-expansion pumping engine of 3,000,000 gal. capacity at a cost of $21,400. Early in 1911 two horizontal duplex compound condensing pumping engines, one of 3,000,000-gal. capacity and the other rated at 1,500,000-gal., were installed, the total cost of the installation being $16,165.40. At this time much of the pumping was done by the triple-expansion pump, the smaller compound pump being in use practically every day in the year and the larger compound kept under steam for emergency use in case of sudden demand or when repairs were being made to the vertical unit.

The boiler plant consisted of three 130-hp. water-tube boilers carrying a steam pressure of 125 lb., two installed in 1898 and the third in 1909. One year later all three boilers were equipped with underfeed stokers at an installation cost of $3457.51. Sufficient boiler capacity to operate the entire plant was supplied by two boilers. Water for all purposes was obtained from a system of eight artesian wells, ranging from five to ten inches in diameter, deriving their supply from the strata of Potsdam sandstone underlying southern Wisconsin. The average depth of the wells was about 800 ft. and the discharge from each of the larger ones approximated about 1,000,000 gal. per 24 hours. Four of

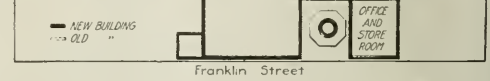

FIG. 1. PLAN OF THE PUMPING STATION

the wells had been located on the station grounds and, as originally they were flowing wells, had been connected for direct suction. Late in 1914 measurements showed that the water plane had been lowered to 14 ft. below the ground surface, so that an air-lift system, consisting of two motor-driven compressors and four air-lift pumps, was installed to increase the capacity of the wells. The four outside wells were operated by individual motor-driven deep-well pumps, two of the propeller type and the other two, turbine pumps. In the main station a 100-kw. direct-current generator directly connected to a Corliss engine supplied the electric energy, and provision was made to obtain power also from the central station. A 200,000-gal. brick reservoir and a 1,000,000-gal. reinforced-concrete reservoir gave storage capacity. There was direct connection to the pump suctions in the station. Distribution was by direct pressure with a 50,000-gal. elevated tank for regulating the domestic pressure.

With the station enlarged from time to time without regard to future system or appearance, it eventually contained a heterogeneous mass of machinery, little of which was suited for a permanent and economical installation. It had been purchased mostly to meet immediate necessities and had been crowded together without sufficient room for operation and repairs. The boiler room was dark and the coal storage provided was inconvenient, so that the labor of handling coal was great. Another disadvantage was the location in a residential district, imposing an expense of several thousand dollars per year for coal handling. In addition the pumping machinery had become inadequate in capacity for any considerable fire, even with every pump in use, and the water supply was not sufficient to furnish reasonable protection. Owing to the latter contingency, additional wells were necessary and more reservoir capacity to provide sufficient reserve.

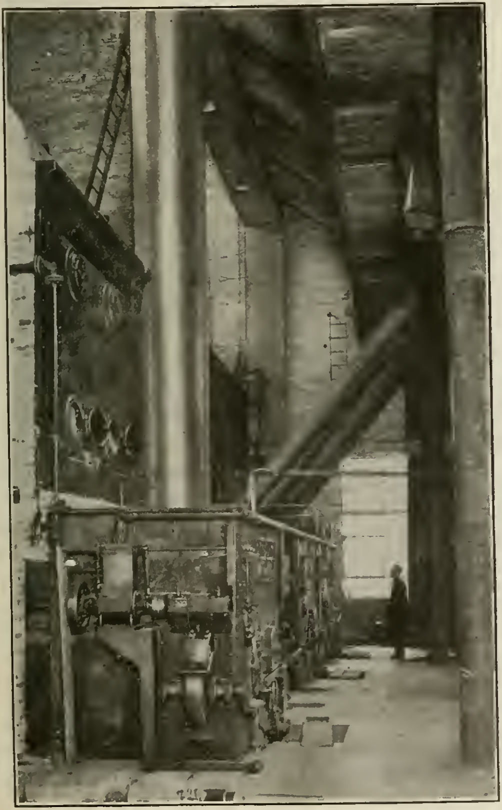

FIG. 2. THREE NEW 200-HP. STIRLING BOILERS

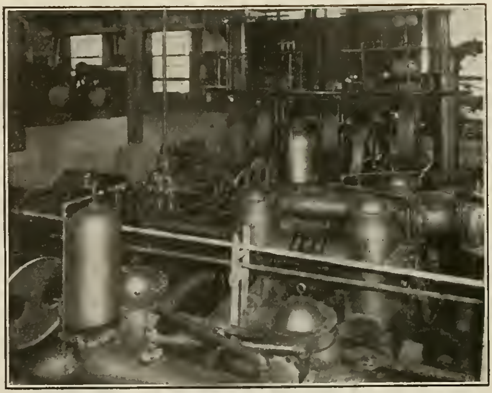

FIG. 3. OLD PUMPING EQUIPMENT RETAINED

Outside of the deficiencies already enumerated, there were objections to the water supply. The artesian water was very hard, costing the citizens of Madison thousands of dollars annually for extra soap, loss of fuel and cost of repairs to boilers and heating systems due to the formation of scale. The cost of the pumping was high because of the double pumping required, and this cost would increase as the static level of the well water fell with the increasing demand. Besides the additional operating expense in the station, a great deal of trouble and expense had been experienced in the operation and maintenance of the deep-well pumping machinery, and there would be need for a revision of plans every few years for securing additional water as the demand increased.

For these various reasons a report prepared for the city by prominent consulting engineers of Madison and Chicago favored drawing the water supply from Lake Mendota, which is within 500 ft. of the station. It has an area of 15 square miles, and disregarding rainfall or evaporation, one foot of its level would furnish Madison with eight million gallons per day for an entire year. The adoption of this source would solve the water-supply problem for Madison for all time to come. Compared with the artesian supply the lake water contained only about one-half the mineral matter in solution and would thus be more satisfactory for manufacturing, boiler and laundry uses. The great volume of lake water would give unlimited fire protection. The operating expense would be less as would the ultimate cost of development.

The only objection was the need of continuous purification by chlorination and filtration and the initial expense this equipment would entail. The size of the filters and their cost could be reduced by retaining the artesian-well system as an auxiliary fire supply to be used by pumping directly into the city mains.

In studying the problem of increased water supply a total of sixteen different plans of possible development were considered. Electricity had been used satisfactorily for low service pumping from the wells to the reservoir and was considered for high-service pumping as well. Due consideration, however, showed its use for the latter service to be impractical on account of the great variation in the necssary rates of pumping. Although moving the plant to a new location adjacent to the railways would effect a saving in the cost of hauling coal, would remove the station from a residential district and would give better opportunities for economical design, especially for future enlargements, the first cost seemed unwarranted at that time. A full consideration of all details reduced the problem to two solutions, both using the present location of the pumping station further developed with a water supply from artesian wells in one case and a supply from Lake Mendota in the other. The city council adopted the former plan.

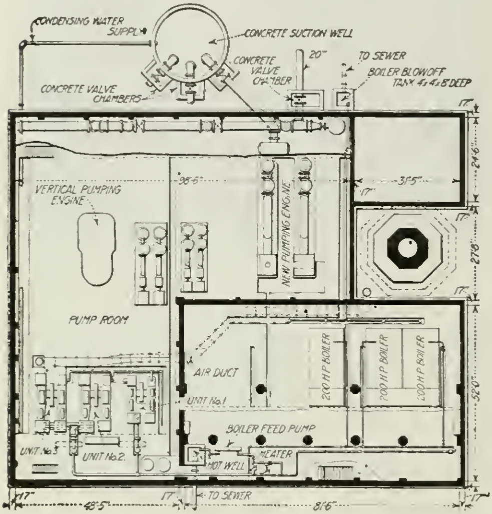

FIG. 4. SHOWING ARRANGEMENT OF EQUIPMENT

An entirely new building was constructed on the site of the old one. Three new 200-hp. water-tube boilers were installed in a modern boiler room equipped with elevated concrete coal bunkers, coal and ash-handling machinery and a new radial-block stack of ample proportions. A new eight-million gallon cross-compound crank-and-flywheel pump was installed to carry the load, and the two horizontal compound pumps and the vertical triple expansion pump were retained as reserve units. The generating set, the two motor-driven air compressors and the deep-well motor-driven pumps were removed and in their place three steam-driven compressors with air-lift pumps on all wells (four at the station and six outside) were substituted.

Thus all machinery in the station is steam-driven. For the high-service pumping directly into the main, proper speed regulation gave no choice, and with the boilers installed it was considered good practice also to operate the low service by steam, the added coal cost being about the only additional expense to be considered. A new concrete reservoir of 1,500,000 gal. capacity was built and cross-connected with the 1,000,000-gal. reservoir. Both are supplied from the low-service air-lift system and have common connection to a new suction well to which all high-service pumps are now connected.

It was decided to erect a new building over the old one, the work starting in May, 1917. The job was particularly interesting and difficult as continuous service had to be maintained, it being necessary to install the new equipment before the old could be removed. Fig. 1 shows the relative proportions in plan of the two buildings. A temporary wooden building was constructed

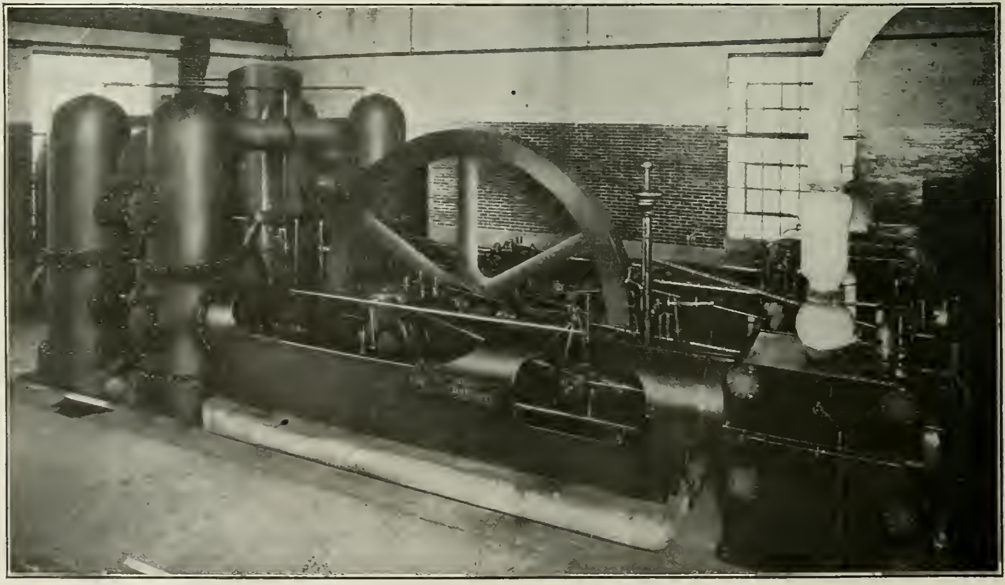

FIG. 5. THE CORLISS ENGINE-DRIVEN 8,000,000-GAL. PUMPING UNIT NEWLY INSTALLED

over the pumping machinery, and the old building was torn down with the exception of that part of it housing the old boilers. Construction of the new boiler room for the first two boilers was started, and, simultaneously, work began on the new pumping room, the foundations coming outside those for the old building. A new stack 6 ft. in diameter and 150 ft. high was erected.

When the first part of the new boiler room was completed two boilers were installed and put into service as soon as the piping connections could be made for carrying the station load. The old boilers were then dismantled, the old chimney torn down and the balance of the boiler room completed. Another boiler was installed, with space for two more, and the coal- and ash-handling equipment put in place.

With the roof over the new pumping room the temporary wooden inclosure was torn out and the new eight-million gallon unit put into commission. This gave an opportunity to remove the old 2,500,000-gal. duplex geared pump, the motor-driven air compressors and the generating set to make room for the three steam-driven air compressors serving the new air-lift system. The two compounds and the vertical triple-expansion pumps remained on their old foundations. The high-pressure steam piping was transferred to the new header, the suctions were changed from the old to the new suction well and the discharge of all pumps connected into a common 30-in. header in the pipe gallery. The normal water pressure is 85 lb. and the maximum fire pressure 125 lb. The speed of the new pump is controlled by a water-pressure governor and that of the older pumps by means of the steam throttle. Each of the pumps is equipped with the usual water-works type of condenser with steam-driven auxiliaries. The general layout of the station is given in Fig. 4, and Figs. 3 and 5 show the pumping equipment.

Fig. 2 is a view of the new boilers, the installation of the third boiler having just been completed. Each unit is of the Stirling type and rated at 200 horsepower. The operating pressure is 150 lb., with no superheat. The stoker equipment is of the top-feed type operated by vertical engines, there being one on each outside stoker, as indicated in the photograph. Steam to the pumps and air compressors is supplied through a ring header making the circuit of the pumping room. It is supported by wall brackets with walking-board attachments. In the boiler-feed piping the ring system is also employed.

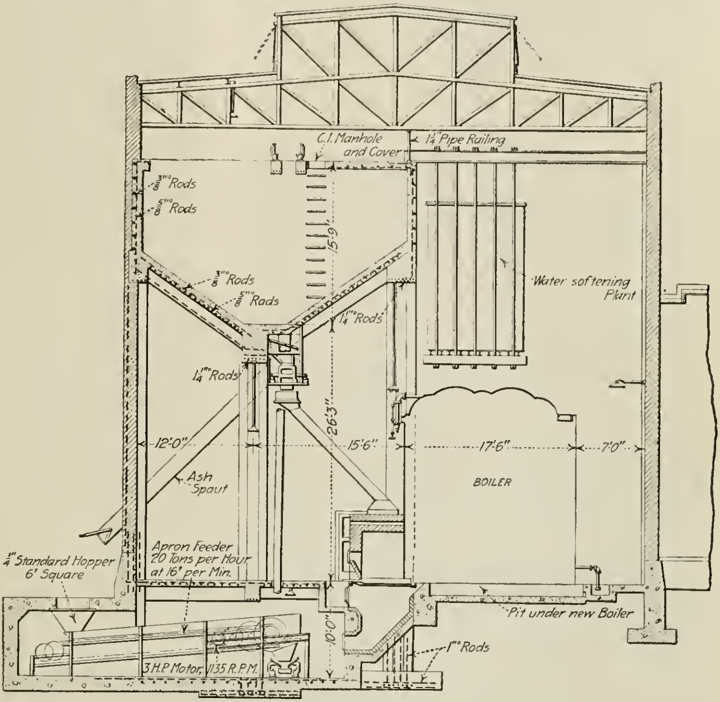

FIG. 6. SECTIONAL ELEVATION OF THE WATER-WORKS BOILER ROOM

Fig. 6, a sectional view of the boiler room, shows the arrangements for coal and ash handling. The coal is delivered in trucks and dumped into a hopper under the driveway. By an apron conveyor it is transferred to a continuous bucket carrier delivering to individual overhead reinforced-concrete bunkers having an aggregate capacity of 500 tons. Each conveyor is motor-driven, and the rated capacity of the system is 20 tons per hour. The continuous bucket conveyor has the now standard feature by which a bucket out of line shuts off the power and stops the carrier. From the bunker the coal is passed through an automatic coal scale into the bifurcated spout feeding the stoker. Each scale is provided with a motor-driven screw used to feed the coal into the scale hopper when it is wet and will not flow readily. Another provision not always made is a spout from each bunker to the lower run of the conveyor in the basement. If the coal starts to heat in the bunker, it can be dis-

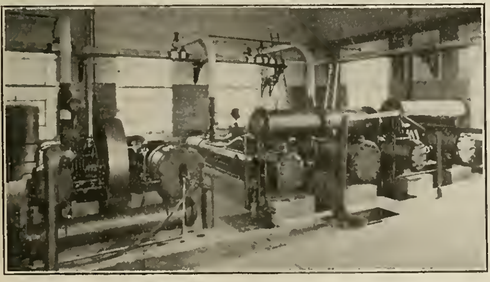

FIG. 7. VIEW OF THE NEW AIR COMPRESSORS

charged into the conveyor and given a chance to cool on its way back to the bunker.

Ashes are shoveled directly from the hopper under the stoker into the bucket conveyor, the distance from the hopper door to the conveyor being about six feet, and are elevated to an overhead bunker provided with a spout leading out to the driveway.

Feed water for the boilers is principally condensation, all of which is collected in a hotwell located above direct-acting boiler-feed pumps. By these pumps the water is forced through either unit of a twin grease extractor and a vertical closed heater to the boilers. The pumps are equipped with pressure governors, and each boiler has its individual feed-water regulator.

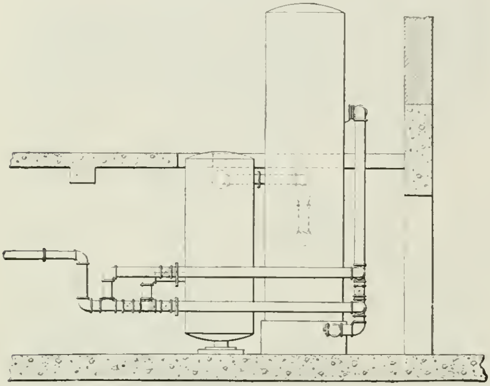

FIG. 8. CONNECTIONS OF THE COMPRESSED-AIR TANKS

To remove the scale-forming matter in the artesian water used for makeup, a softener employing soda ash and having a capacity of 2000 gal. per hour, has been provided. It is suspended from beams spanning from the outside wall to the top of the bunkers. Water from the storage compartment of the softener goes to the hotwell under float control.

One of the interesting features of the plant is the new air-lift system serving the ten artesian wells supplying the city with water. For the low-pressure pumping, primary steam units were desired as they would add little more than the cost of coal to the steam requirements of the high-pressure service. In addition the air-lift pump is simple, requiring little attention, and with a booster tank that will discharge the water against a combined head of 80 ft., by means of accumulated air, into the reservoir, was quite feasible in the present case. The most remote well is about 4000 ft. distant from the plant.

In the station the steam-using equipment consists of three cross-compound air compressors, one having a capacity of 940 cu.ft. per minute and each of the remaining two 1500 cu.ft. per minute. The steam ends are equipped with surface condensers, having steam-driven auxiliaries. The condenser serving the smaller compressor has 400 sq.ft. of cooling surface. A second condenser serving either of the two larger compressors has 500 sq.ft. of surface. Normally, only one of the larger compressors is operated at a time to supply air for the six outside wells, while the smaller compressor serves the four station wells. These machines are shown in Fig. 7, and Fig. 8 shows how the receivers are cross-connected so that if desirable any machine may be used on either service or on both. The station wells discharge into the old suction well, which has connection with the 1,000,000 gal. reservoir, and the outside wells, with one exception, will eventually discharge into the new reservoir. As previously stated, both reservoirs are cross-connected and have a common main to the new suction well now supplying all high-pressure pumps.

COST OF IMPROVEMENTS IN MADISON WATER WORKS

Concrete storage reservoir	$19,752.58
Suction well	2,367.43
Repair to old storage reservoir	2,452.66
Equalizer main	22,038.81
Stack—6x150 ft., including foundation	5,349.33
Station building	96,713.89
Boiler and stoker equipment	26,228.01
Air and discharge lines	14,395.82
Air compressors and air-lift equipment	34,473.80
Pumping engine and discharge pipes	38,897.04
Discharge header	10,449.74
Miscellaneous equipment and construction expense	6,892.51
Steam and station water pipe and covering	17,472.55
Steam heating	1,364.48
Coal- and ash-handling machinery	12,711.12
Water softener	3,060.34
Sidewalks and improvements to grounds	2,000.00
Total cost, exclusive of engineering	$316,620.11

From the large receiver a 6-in. pipe leads out of the station to the outside wells. As it progresses, it is reduced to 5 in. and then to 4½ in. The line is laid in the ground and is protected from corrosion by machine-wrapped canvas painted with asphaltum. To each well there is a 2-in. branch connection, and the discharge pipes from wells of 8, 10 and 12 in. diameters are 5, 6 and 7 in. respectively. The pressure out of the station

PRINCIPAL EQUIPMENT OF MADISON WATER WORKS, MADISON, WIS.

No.	Equipment	Kind	Size	Use	Operating Conditions	Type
3	Boilers	Water-tube	200-hp.	Generate steam	150 lb. press., natural drafts, stokers	Stirling
3	Stokers	Top feed	40-sq.ft	Serve boilers	....	Murphy
1	Stack	Radial brick	6x150-ft.	Serve boilers	....	Heine
3	Scales	Automatic	....	Weigh coal to boilers	Special screw feeder for wet coal	Richardson
1	Conveyor	Apron	20 tons per hr. at 16 ft. per min.	Coal from hopper to cont. conv.	Driven by 3-hp. G.E. ind. motor	Link-Belt
1	Conveyor	Cont. bucket	20 tons per hr. at 40 ft. per min.	Elevate coal to bunkers	Driven by 5-hp. G.E. ind. motor	Link-Belt
1	Heater	Closed, vertical	111 sq.ft	Heat feed water	Exhaust steam	Whitlock
1	Softener	Cold process, soda ash.	2,000-gal. per hr.	Soften makeup	....	Graver
1	Pump	Simplex outside center packed	8 x 5 x 12 in	Feed-water	....	American
2	Pumps	Duplex	6 x 4 x 6 in	Feedwater	Old	Prescott
1	Pumping engine	Crank and flywheel	8,000,000-gal	High-pressure service	150-lb. steam, normal water press; 85lb.	Allis-Chalmers
1	Condenser	Surface	650-sq.ft	Serve 8,000,000-gal. pump	Steam-driven auxiliaries	Allis-Chalmers
1	Pumping engine	Triple-expansion vertical.	3,000,000-gal	High-pressure service	150-lb. steam, 85 lb. water	Allis-Chalmers
1	Condenser	Surface	311-sq.ft.	Serve 3,000,000-gal. pump	Steam-driven auxiliaries	Allis-Chalmers
1	Pump	Horizontal-duplex	3,000,000-gal	High-pressure service	150 lb. steam, 85 lb. water	Prescott
1	Condenser	Surface	....	....	Steam-driven auxiliaries	Prescott
1	Pump	Horizontal-duplex.	1,500,000-gal.	High-pressure service	150-lb. steam, 85-lb. water	Prescott
1	Condenser	Surface	....	....	Steam-driven auxiliaries	Prescott
2	Air compressors	Cross-compound	1,500-cu.ft. per min.	Serve air lift	Steam 150 lb., air 110 lb	Ingersoll-Rand
1	Condenser	Surface	500-sq.ft	Serves either 1500-cu.ft. comp.	Steam-driven auxiliaries	Wheeler C.&E. Co.
1	Air compressor	Cross-compound.	940-cu.ft. per min	Serves air lift	Steam 150 lb., air 110 lb.	Ingersoll-Rand
1	Condenser	Surface	400-sq.ft	Serves 940 cu.ft. comp	Steam-driven auxiliaries	Wheeler C.&E. Co.
1	Air-lift system		10 wells	Water from wells to reservoirs	Station wells lift 14 ft., outside wells, 800 ft	Indiana

is 110 lb. gage, and the drop in the line is not more than 4 or 5 lb. The output from wells of the diameters given are 500,000, 900,000 and 1,375,000 gal. each per 24 hours, giving a total of over 5,000,000 gal. from the six outside wells. To lift the water to the surface from the wells and deliver it by means of the separator pumps to the reservoir requires 56.5 i.hp. per gal. per min. At the present writing no tests have been made that would determine accurately the cost per indicated horsepower.

The entire work of remodeling the water-works system was under the direction of Daniel W. Mead and Charles V. Seastone, consulting engineers, of Madison, Wis. R. G. Walter, of this firm, had direct supervision of the construction.

Selection of Proper Starting Switches for Induction Motors

By H. Southwood

When selecting starting switches for induction motors, due consideration should be given to the service voltage, the normal ampere capacity, the desired protection, the starting characteristics of motor, the nature of the load, the average number of operations daily, direct operation or shipper-rod operation, inching and the inspection of the equipment.

Small motors up to 5 or 7.5-hp. capacity, operating on 550 volts or less, may be thrown directly across the line without causing a serious drop in voltage. For motors above 7.5 hp., central stations usually require their customers to furnish some means of starting at reduced voltage so that the starting current will not cause the line voltage to fluctuate excessively.

Three-phase motors are sometimes started and brought up to speed with a star connection of the windings and then connected in delta for running. However, the most common method of starting induction motors is by the use of an auto-transformer or compensator, which provides taps for starting at reduced voltage. The auto-transformers are usually disconnected from the line and from the motor when the starter is in the running position, with the motor connected directly to the line.

The current-carrying capacity of the starter should be large enough to take care of the starting current and the overload-rating guarantee of the motor (usually 25 per cent. for two hours). For instance, the starting switch for a squirrel-cage induction motor whose name-plate amperes is 10, should be able to carry approximately 60 amperes for the period of starting (2 to 6 seconds), 12.5 amperes for 2 hours and normal amperes indefinitely without excessive rise in temperature of the current-carrying parts.

In the case of induction motors protection for the running conditions will not in general stand the strain of starting conditions, the conditions are so radically different that protection for starting conditions affords little or no protection for running conditions. Hence, in many cases the starter provides for a starting position at either reduced or full voltage, with no other protection than the fuses in the branch and main circuits, and a running position that provides additional protection to suit the running conditions of the motor.

If the motor is protected by fuses in the running circuit only, it is common practice to select a fuse whose continuous current-carrying capacity will allow for the overload guarantee of the motor and will blow when the current exceeds this amount. The table shows the results obtained from a test made on fuses of five different manufacturers to determine the time required for them to open the circuit when carrying 200 per cent. normal current. From the table it is seen that the time varies from 3 to 29.5 sec. However, any motor will carry 200 per cent. full load without injury for a much longer period than given in the table.

NATURAL TIME LAG OF 10-AMPERE FUSES

Fuse Rating, Amperes	Per Cent. of Rated Current	Time Lag in Seconds
10	200	17.5
10	200	29.5
10	200	8.3
10	200	3.0
10	200	5.5

If the motor is protected by series overload relays, it is common practice to set the overload devices to operate when the current exceeds approximately 130 per cent. of the name-plate amperes of the motor. A time-limit attachment or some other retarding device should be used to prevent the starter from tripping momentary overloads or during the starting period. Means should also be provided for preventing the restarting of the motor upon the reëstablishment of normal voltage after total or partial loss of voltage, until the starter has been brought to the "off" position. This protection is usually furnished by a so-called undervoltage trip attachment.

Induction motors of different manufacture have practically identical starting characteristics as far as switching equipment is concerned. The starting current of different induction motors varies from 450 to 600 per cent of the full-load current and is practically independent of the load.

The starting current decreases to normal running current almost instantaneously when the motor starts with no load, and in 4 to 8 sec. when it starts with full load. Loads that require more time for the motor to reach normal running speed are considered as special applications and may require special retarding devices on the starting switch.

The useful life of a properly selected starter depends mainly on the number of operations daily and on the thoroughness of inspection. The average starter is good for five to ten years of service in the usual application before mechanical deterioration causes the switch to fail. With frequent inspection of the current-carrying parts and renewal of the contact members when necessary, failure due to electrical deterioration is very remote. Mechanical and electrical deterioration is generally more excessive with shipper rod operation than with direct manual control. For motors whose connected load requires "inching," starters with a quick-make and quick-break contact mechanism will give longer service per set of contact members than other types. The quick make-and-break mechanism tends to prevent teasing of the contacts and excessive burning and pitting of their surfaces, which frequently causes abnormal heating. Periodical inspection of starting switches is of great importance. Many expensive shutdowns are prevented by renewing contact members and other worn parts before they fail.

Sir Robert Borden, the Premier of Canada, in a statement dealing with the natural resources of the Dominion, emphasizes the great force of potential energy in the form of water power. On the River St. Lawrence alone, between Lake Ontario and Montreal, he estimates that 2,500,000 hp. can be developed.

Lubrication in the Power Plant

By J. D. ROBERTS

General requirements and points to be considered in the selection of an oil. The meaning of viscosity and how determined. A number of simple tests that may be made by the plant operator.

EXTREME care is necessary in selecting lubricating oils for a specific purpose. Careful study and investigation into the friction and the characteristics of the various machine bearings and such parts as are to be lubricated is essential before selecting the oil for that particular work. As a general rule there are two kinds of friction in machines to be lubricated—solid friction resulting from actual contact of a moving surface, and fluid friction due to the resistance the lubricant offers to motion. Since solid friction is much greater than fluid friction, lubricants are used to separate the moving parts of machines and so substitute fluid friction for solid friction. With smooth bearings at high speeds and under moderate pressures, this substitution is practically complete with a suitable oil, and the friction developed is proportional to the true viscosity of the oil. It is needless to state that solid friction produces a greater loss of power and greater heating of the bearings with a consequent lowering of the viscosity of the oil by heating and wear.

Conditions Determining Selection of Oils

In perfect lubrication the moving part is entirely supported or floated on a film of oil that should be of sufficient thickness to keep the journal and bearings apart under all reasonable conditions. To maintain such a film, the oil must have sufficient viscosity or body. Pressure, speed, working temperature, condition of the bearings and the method of oil feed determine the most advantageous oil to use. As a rule high pressures on bearing surfaces require oils of higher viscosity than do low pressures. Naturally, this should be expected because of the greater weight per square inch of bearing squeezing the oil from between the friction surfaces. It is also a general rule that with the same bearing pressures a fast-moving journal can be lubricated satisfactorily with a thinner or less viscous oil than can a slower journal. This is apparently due to the fact that the speedier journal sucks in more oil between the moving parts, thus aiding in maintaining the film. For bearings that operate at high temperatures, such as in the electric motor, an oil of greater viscosity is required than for bearings of lower working temperature under similar speeds and pressures. High operating temperatures greatly reduce the viscosity of the oil. For rough bearings an oil of high viscosity is required to maintain a thick film that will reduce the actual contact of the bearing and journal to a minimum.

Another condition common to general lubrication is that with a circulating or force feed, oil of lower viscosity can be used on account of the increased amount of oil reaching the bearing, which partly compensates for the oil squeezed out. Naturally, the excess oil also tends to reduce the temperature of the oil film and cool the bearing. As a great volume of oil circulated will carry off a large quantity of heat from the bearings the oil does not become highly heated and consequently maintains its viscosity.

Since a number of references have been made to the viscosity of an oil, some explanation of this property may be in order. By the viscosity of an oil is meant its internal friction or resistance to flow. It refers to the same property as do the terms "body" and "cohesion." For true liquids, viscosity varies inversely as the fluidity. The viscosity is usually measured with a viscosimeter, by noting the time required for a given volume of oil to flow through an orifice of definite size under a given pressure. With commercial viscosimeters, such as the Saybolt and the Engler, the tube is too wide and too short for the real friction of the oil to be registered accurately. Consequently, such instruments do not show the true viscosities of oils though they serve a valuable purpose in classifying oils in the order of their viscosities.

Testing The Viscosity of Lubricants

The Saybolt viscosimeter is generally accepted throughout the United States as being the standard instrument for determining the viscosity of lubricating oils. It requires only a small amount of oil for the determination. The time of the outflow of 60 c.c. of oil approximately in seconds is taken as the viscosity of the oil at the temperature used. This viscosimeter requires about 28 sec. for 60 c.c. of distilled water to flow out at a temperature of 68 deg. F. It is to be noticed that the temperature at which the viscosity is taken enters into the final decision as to the actual viscosity of an oil. For this reason the viscosity of a lubricating oil should be tested at approximately the temperature under which it will be required to give service. It would be manifestly an unfair comparison to consider an oil, say for steam-cylinder lubrication, at the viscosity obtained at 100 deg. F. when the actual working temperature encountered might be as high as 400 deg. F.

This line of reasoning should also apply to engine and journal oils. Use of an engine oil, whose viscosity is given in periods of seconds at 70 deg., in a journal whose temperature with safety to the lining could exceed 180 deg., would not be considered, as proper maintenance of the viscosity under the higher temperature could not be expected. As a general rule and if it is possible for relative comparison, 100 deg. is used in viscosity statements by oil manufacturers. The common expression for a certain oil would be 50 sec. of viscosity at 100 deg. F., meaning that it required 50 sec. of time for 60 c.c. of that particular oil to flow through the orifice of a Saybolt viscosimeter at a temperature of 100 deg. F.

From the viewpoint of a practical operator, a lubricating oil should have sufficient viscosity to maintain an adequate film under normal working conditions, plus a sufficient amount of viscosity to prevent the bearings coming in contact during abnormal conditions. The best apparatus for testing oils is the equipment in which it is used. Simple tests with thermometers inserted in bearings during the running periods will give the results that are being obtained.

When selecting an oil for the lubrication of certain bearings, the following points are to be considered:

1. The subject of viscosity, already touched upon.
2. The chemical characteristics of the oil. In other words, is the oil an acid-treated oil from which all traces of acid have not been removed?
3. The natural cleanliness of the oil. Will it leave deposits on the various parts of the bearing or journal?
4. From the viewpoint of economy, what would be its rate of evaporation? Is it an oil that might lubricate successfully under high temperature, having a reasonable amount of evaporation and requiring little replacement and removal?
5. The life of an oil in a certain class of service. Can it be withdrawn repeatedly, filtered and put back into service and give satisfactory results?
6. The price of the oil by unit of sale.

There are many simple tests that any plant operator or engineer can make with apparatus procurable around the average power plant, which will give close approximation of the characteristics of a lubricating oil.

To determine whether an oil is acid-treated, dissolve a small piece of sodium carbonate in water. Pour this solution into a flask along with the oil to be tested. Shake thoroughly. Any precipitation is proof of the presence of acid in amounts proportionate to the amount of precipitation.

For the fire test fill a small metal cup, having no seams and holding about two ounces, three-quarters full of oil. Set this on a gas flame or other source of heat and heat slowly to the temperature required. While the temperature is rising, apply a light to the surface of the oil. When there is a flash, note the temperature. This is the flash point. Keep the cup covered and apply the light or flame between the cover and the oil. Continue the heating to a point where the oil will burn continuously. This is the burning point of the oil.

To make comparative determinations of the viscosity of an oil, take a small seamless brass tube with one end closed by brazing so as to prevent melting. Make a small orifice in the center of the bottom of the tube, about $\frac{1}{64}$ in. diameter. The bottom of the tube should be about $\frac{1}{8}$ in. thick to give the proper length to the orifice. Fill this tube with water and with a stopwatch notice the time required for 60 c.c. of water to flow through the orifice at a temperature of 68 deg. F. Then fill the tube with the same amount of oil and notice the time required for the 60 c.c. of oil to flow through the orifice. The oil time divided by the water time will give a relative expression of the viscosity of the oil.

The specific gravity of the oil can be determined only by means of a hydrometer graduated to the Baumé scale. To reduce to terms of specific gravity use the following formula:

$$\textit{Specific gravity} = 140 \div (\textit{Degrees Baumé} + 130)$$

The tendency of an oil to oxidize when exposed to air is of considerable importance. To make a relative determination of this characteristic procure a piece of polished steel about six inches wide and six feet long and fit it in an inclined position with a rise of one inch to the foot. Upon the highest point place drops of the different oils to be compared, notice the time that they are starting, the amount of the decrease and the rate of progression day after day. The oil that runs the steadiest and goes the farthest is the best.

The presence of gasoline and mineral soap in lubricating oil is undesirable. To determine the presence of these two elements, dissolve 15 drops of the oil in a cup filled with gasoline. Put the mixture in a test tube and add 15 drops of metaphosphoric acid and allow it to settle. If any change takes place, it is caused by the presence of mineral soap or gelatin, which are added to some oils by the manufacturer to give them high-viscosity characteristics.

Taking a sample of oil in a shallow test tube and putting it in a freezing solution of ice brine will give a clear idea of its tendency to solidify and become nonfluid when subjected to low temperatures.

General characteristics of transformer oil should be such that it will have a high dielectric strength. It must have a high flash point to prevent its ignition during the opening of circuit-breakers and the failure of transformers, feeder regulators or electrolytic lightning arresters. Where oil is used for cooling purposes, it must have low viscosity to allow free circulation and must be free from deposit to prevent the obstruction of oil ducts. For use in oil circuit-breakers it must have high viscosity to prevent undue splashing, and in electrolytic arresters it must have high viscosity to permit the formation of a sufficiently heavy oil film.

The dielectric strength of the clean dry oil is usually not less than 40,000 volts when tested between $\frac{1}{2}$-in. brass spheres set 0.15 in. apart, or 22,000 volts when tested between 1-in. disks set 0.1 in. apart. Care should be taken to keep these oils absolutely dry under all conditions. The presence of water in as small an amount as 1 per cent. is sufficient to impair seriously the dielectric strength of the oil.

Any oil for insulating purposes in electric apparatus should be absolutely free from all acids or alkali for the reason that acid or alkali reduces the dielectric strength of the oil, and secondly, acid or alkali is corrosive or destructive in its action on the materials of the apparatus. The oil should be as light in color as possible to permit a good view and inspection of the apparatus submerged in the oil. Its factor of evaporation should be low.

Lubricating greases are used for bearings where the pressure is not too great. Greases are used for lubricating parts of machines and to prevent undue splashing of the oil. The most general type of lubricating grease today in use is the soap-thickened oil made by compounding mineral oil of different grades of viscosity with amounts of lime soap, soda soap or other mineral soaps. The quality of these greases is determined by the character of the mineral oil, kind of soap and amount, friction of the oil, the presence of water in the grease, and lastly by the process of manufacture.

Pulling in Conductors with a Crane*

BY TERRELL CROFT

Some suggestions on how to use a traveling crane to pull large electrical conductors into conduits.

CRANES are available in most industrial plants and power houses of any consequence. They are frequently installed in buildings under construction, assuming that sufficient steel has been erected to carry them, inasmuch as they are useful in handling construction materials and equipment for the new building. The electrical-construction men and operating engineers can utilize them for the rapid and economical pulling of heavy electrical conductors into conduits.

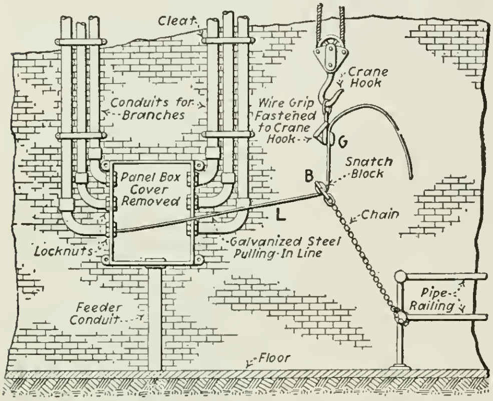

FIG. 1. PULLING IN WIRE WITH A CRANE HOOK

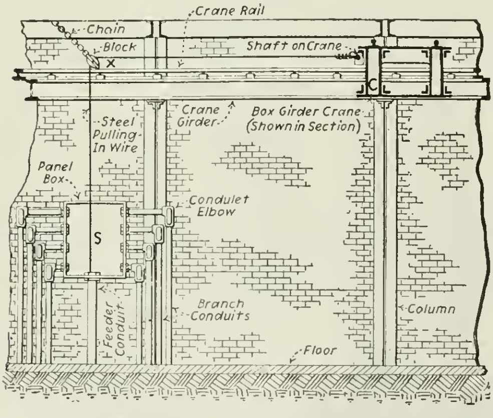

FIG. 2. DRAWING IN CONDUCTORS WITH PULL-IN LINE ATTACHED TO CRANE BRIDGE

A method of pulling in conductors with a crane hoisting hook is given in Fig. 1. The pulling-in line *L* is of galvanized steel. The attachment between it and the crane hook is effected by means of the parallel-jaw wire grip *G*. To insure that the pulling-in line will pass directly out of the branch conduit without excessive binding, the snatch block *B* is arranged and restrained with a chain as shown.

A crane capable of hoisting from, say, 3 to 5 tons at 75 or 100 ft. a minute makes short work of a condition such as that shown in Fig. 2, which presents the arrangement necessary for pulling in a vertical feeder with a bridge crane. A steel wire *S* is used for the pulling-in line. It is attached to the crane at *C*. A snatch block *X* alters the direction of the pulling-in line from the vertical to one parallel to the crane girder. Where feasible, it is preferable to attach to the crane bridge rather than to the hook, because the bridge speed is faster than that of the hook. Furthermore, it is usually possible to pull in a much greater length of wire at one setting where the pulling-in line is attached to the bridge instead of to the hook.

In pulling around a corner with a crane it is necessary to use a snatch block. In a building where there are cranes, it is seldom that any conduit outlet will be so situated that it cannot be pulled from in some way or other by one of them. Several snatch blocks may be required in different cases, but unless too many changes in direction are necessary, it will probably pay to use the cranes. Figs. 3 and 4 (Fig. 3 is a front elevation and Fig. 4 a plan view) illustrate an example where a pull is being made around a corner. The connection between the fishing wire and the crane is the same as that described in Fig. 2: that is, the fishing line is attached to the shaft of the bridge crane.

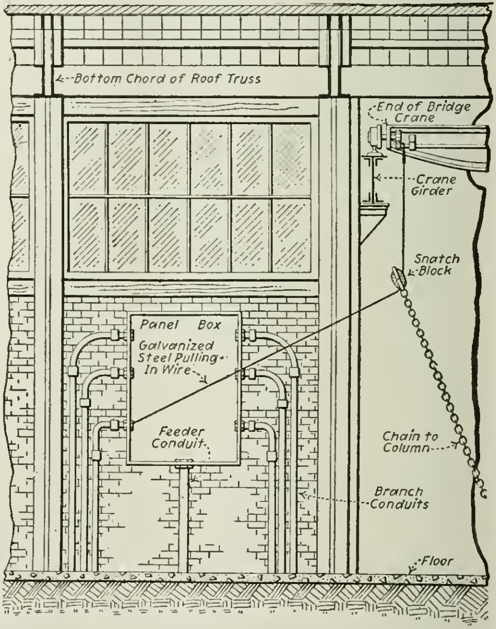

FIG. 3. A PULL AROUND A CORNER. PLAN VIEW OF THIS ARRANGEMENT SHOWN IN FIG. 4

A sheave mounted in a pull box may be used instead of a snatch block, as in Fig. 5, under certain conditions.

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*Copyright, 1919, by Terrell Croft.

In the example given in the figure the wooden sheave rotates on a length of ½-in. conduit, which serves as an axle. This axle is held in knockout holes punched in the bottom and in the top of the box for its reception. The expedient suggested is particularly applicable where the pull box or the outlet from which the conductors are to be drawn is located in a corner, as in Fig. 5, where a direct pull longitudinally from the conduit would be impossible. Where such a condition exists, the designer should plan in advance and have the knockout holes to support the axle punch in the pull box when it is made. Monorail cranes may be employed for pulling in wire as indicated in Fig. 6. Cranes of this type are much lighter than those of the bridge type. Hence, on heavy pulls the wheels may slip and spin around on the I-beam monorail. When slipping thus occurs, two or three of the cranes may be coupled in tandem. Or if this expedient fails, the pulling-in line should be rerouted so that the pulling can be done by the crane hook. The hook may be capable of raising 3 to 5 tons.

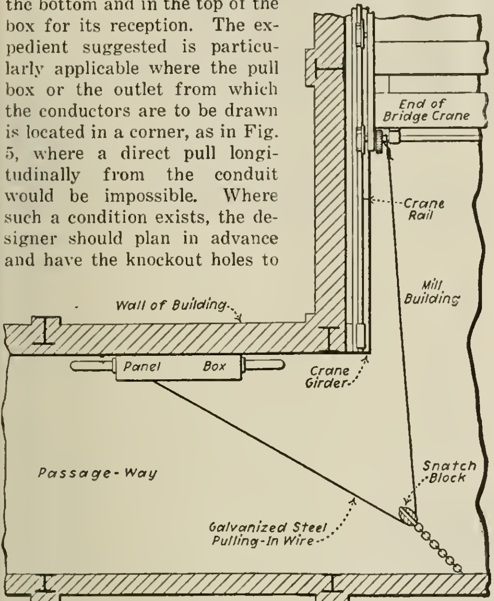
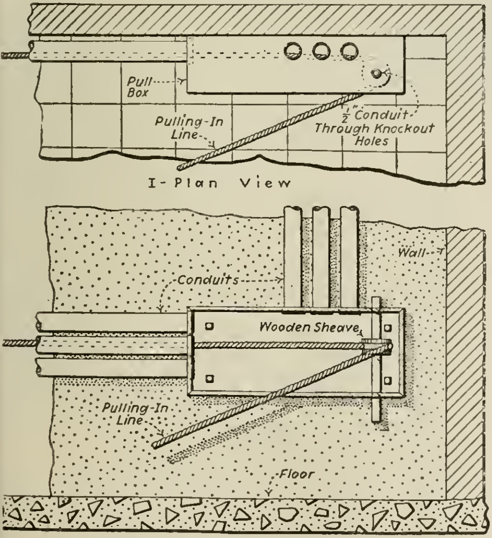


FIG. 4. A PULL AROUND A CORNER. ELEVATION OF THIS ARRANGEMENT SHOWN IN FIG. 3



I - Plan View

II - Front Elevation

FIG. 5. SHEAVE FOR PULL-IN LINE FOR USE IN CONFINED LOCATIONS

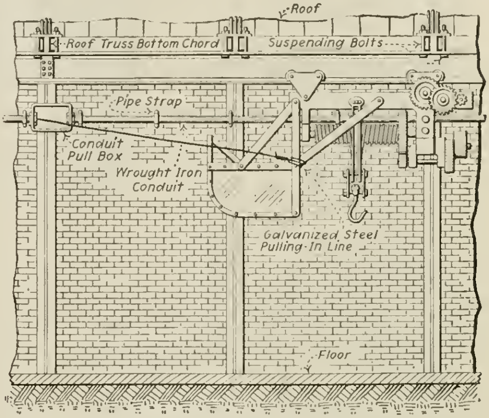


FIG. 6. PULLING IN CONDUCTORS WITH A MONORAIL CRANE

Locomotives, steam or electric, may supply the pulling-in medium. Occasionally, conditions are such that the yard locomotives in industrial or power plants may be thus pressed into service. In certain installations many hundred feet of conductor have been drawn in by this method. It is a satisfying spectacle to observe the ease with which a yard locomotive will haul in conductors which have responded but feebly to the block-and-tackle method.

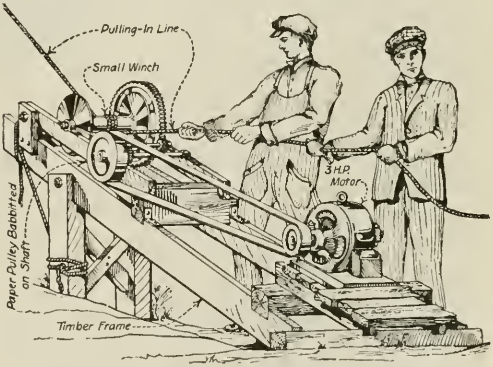


FIG. 7. PULLING IN CONDUCTORS WITH A MOTOR-DRIVEN WINCH

Where none of the foregoing mediums is at hand and there is a considerable number of heavy conductors to be pulled into conduits, it may be possible to make use of a motor-driven winch, as shown in Fig. 7. An old winch was modified by removing the crank and babbitting a pulley to the shaft. Then the winch and the 3-hp. motor were bolted to a couple of timbers. In pulling, the line is given a few turns around the drum of the winch and the motor started. In the meantime the wireman keeps the line taut, as shown.

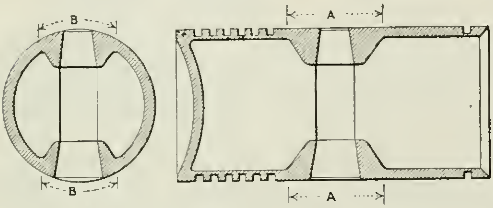
Seized Piston in a Diesel Engine

By D. L. Fagnan

Trouble was experienced through seizing of the piston in a three-cylinder Diesel engine of 225 hp. capacity. For two days the engine had been gradually failing to maintain speed and the exhaust was black, showing that considerable fuel was being used or that the engine was being loaded beyond its capacity. Finally, the engine suddenly stopped with a loud groan and could not be barred over in either direction. The engineer frantically tried to find the cause of trouble, but gave up and called for the nearest erecting man.

A message advised me to drop everything and get on the job quickly. First of all I got a line on the behavior of the engine previous to stopping. This gave me a clue for the purpose of making a diagnosis of the trouble. Next, all front plates were removed from the engine and the crankpin bearings were loosened to give play, so that the pistons could be raised in turn in order to determine which piston had seized.

It was found that the piston of No. 3 cylinder was as solid as iron. So the crank bearings of Nos. 1 and 2 were put normal again and the top gear and head removed from No. 3. Kerosene was poured on top of the piston to help loosen things up a little. One man was set to scraping off the piston head and another to grinding in the valves on all three cylinders. It is our practice always to take advantage of a shutdown to put all the valves and valve seats in first-class condition and to shim up under the piston-pin bearings when necessary, so as to maintain compression.



PISTON IS GIVEN CLEARANCE OVER THE BOSSES

We tried a hardwood block and a sledge on the seized piston, while a man barred the flywheel, but nothing moved. We then applied a hydraulic jack, placed to rotate the flywheel so as to pull the piston downward, while we worked kerosene past the rings and pumped more of it into the lubricant holes in the cylinder liner. It took considerable pressure from the jack, but finally we observed a slight movement, which meant that the worst was over and that all was clear sailing.

The engine was barred over so as to work the piston up and down a few times, while plenty of graphite and oil was allowed to penetrate to the piston rings. This made it an easy job finally to pull up the piston and its connecting-rod and bring them out on the floor. The pistons and rods are heavy affairs and considerable headroom is desirable; but if only four or five feet of clearance is provided over the engine, as is the case in some plants, the removal of a piston and connecting-rod becomes some job. Clamps must be made of hardwood to hold the rod, and the piston must be supported vertically. The piston pin is then driven out, the piston taken down and then the rod. A better method is to cut a permanent opening in the roof and rig up a gallows. This saves considerable time and labor, and a long trapdoor closes the opening perfectly when it is not in use.

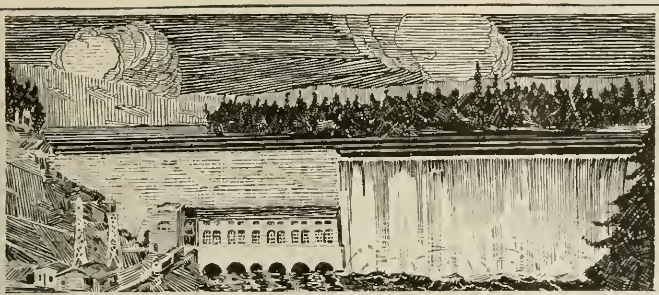
After cleaning the piston with kerosene and gasoline, some very bright spots showed, while abreast of the piston-pin bosses the piston certainly looked chewed up. To my mind, this distinctly indicated a shop error in not providing enough clearance on the piston body at the bosses to permit the expansion that takes place whenever a piston-pin brass is overheated. In the illustration the parts of the piston surface opposite the bosses, as indicated by the areas of length *A* and width *B*, should be provided with clearance while the piston is being made in the shop.

Examination of the cylinder showed some grooving and roughness, and all four lubricant holes practically stopped up with carbon. The use of a half-round file and a scraper, followed by emery cloth on a block of wood curved to fit the liner, made a pretty fair job of smoothing things. This was a five-hour task, but there is no use of doing a poor job on a Diesel-engine cylinder. Good compression is needed to operate at all, and it requires only a small leak to prevent one from getting the 500 lb. per sq.in. needed in such an engine for best results in fuel economy and for parallel operation.

We cleaned out the lubricant holes as well as we could by plugging up three of them and forcing oil through the one left open until it was clear, and doing the same to the others in turn. Then we got busy on fitting a new set of rings to the cylinder liner, while other men set to work to provide clearance on the piston body where it was required. Considerable filing with heavy bastard files was necessary, as 0.02 in. of clearance is required over a considerable area on both sides of the piston. We then fitted the piston rings to their grooves and reassembled the engine. These operations required all day and night without letup.

When we started up again, the engine ran well, so the load was put on and the attendants cautioned to watch the bearings carefully, as these had been keyed up all around; however, no trouble developed. When I told the engineer to remove the other two pistons and give each one the same clearance that had been given to No. 3, he took me to task for not having had this properly done in the shop. I told him it had been done for some time past, but that this was an old engine and the practice was adopted only after reports of piston seizures began to come in.

Apparently, three or four seizures had taken place, which, while serious to the owners of the engine, was but a small percentage considering the number of engines in use; besides, we all learn by experience how to do things better. The piston by caliper gage was 0.006 in. smaller than the liner, which was good practice at the time it left the shop; but it was out of round somewhat and varied from 0.009 in. at one part to 0.015 in. at the smallest part. The front and the back of the piston usually wear most. After a few hours of well-earned rest, I found the engine still running smoothly, so I said good-by to the men all around. These Diesel operators are a fine class of men. They are patient to a remarkable degree, resourceful in emergencies, extremely willing to stay on the job until things are normal, and naturally they get to be fine mechanics, owing to the nature of their work. No botch jobs are tolerated, for each repair must be perfect or it will not be permanent.



POP'S WATER-POWER COURSE

By

John S. Carpenter

"JIMMY," said old Tom Rawlins, the chief of Steam Plant No. 2, "I've got good news for you,"

"How's that, Pop?" replied Jimmy, as he caressed the thrust bearing on the No. 4 turbine and decided that it needed more cooling water.

"You mind you said last winter that the Govamint was encouragin' owners of water-power sites to develop 'em. Well, the company has been buildin' two water-power plants up the river on the quiet, to keep it dark from those proppygander fellers, and now there's a bulletin up that they'll give us all a course of lectures from the operatin' man's viewpoint. And, better still, it ain't goin' to be by one of them high-brow fellers that can't talk without gittin' his chin all full of formulers. From those of us that shows the most intelligence, they're goin' to pick the force for the new plants."

"They might just as well give you one of the plants now," teased Jimmy, "for I can see you burning the midnight oil from both ends of the candle."

"You're darn right, son. S'help me Hanner, I'll git one of 'em! Tonight's the first lecture. Tomorrer we'll review it between ourselves." With that the chief turned into the boiler room to spread the good news.

The company had mapped out a rather interesting course of lectures to be delivered by a hydraulic engineer of the old school, and had arranged to give them so that all the boys would be able to get to them.

The next morning Pop came in to Jimmy with a twinkle in his eye.

"Well, son, how did you make out?" he said. "I thought the feller was easy to understand."

"Ye-e-s," drawled Jimmy, "but I'd like to talk over what he said."

"Well, the first was about the power of a fallin' body. He said that the work in foot-pounds was equal to the weight in pounds multiplied by the distance in feet that it fell through. And he said that power is a rate of doin' work, or the number of foot-pounds of work divided by the time that it's done in."

"I think I see it now," replied Jimmy, "but that rate got me twisted. You mean that we might have millions of foot-pounds of work done in a year and still not have very much done per second or per minute."

JOHN S. CARPENTER

"Right," said Pop approvingly. "It would take ten million foot-pounds to pump one million pounds of water up ten feet, no matter how long you took to do it. But it would take a blame sight bigger pump—that is, more horsepower—to do it in an hour than in a week. Work and power ain't the same, by a long shot! A horsepower is 550 ft.-lb. of work done in one second, or 33,000 ft.-lb. done in one minute."

"Now, he turned it into cubic feet of water per second," Jimmy said, "but he did it so quick that I lost track of it."

"Why, that's simple. You see, one cubic foot of water per second fallin' ten feet is the same as 62.5 lb. of water fallin' ten feet; that is, 625 ft.-lb. of work done per second, or 625 ÷ 550 = 1.136 hp. So then he gave us the rule: Multiply the head in feet by the number of cubic feet per second and that by 62.5 and then divide by 550; then we have the horsepower that would be developed in a perfect turbine."

"Now, Pop, just a second. The head means the distance that it falls through, don't it?"

"You bet! But if you have cubic feet per minute, divide by 33,000 instead of 550. See?"

"He gave us some simple rules," Jimmy went on. "How did he get them?"

"Well, Jimmy, he said that he simply divided the 550 by 62.5, which gave 8.8, so that the rule could be shortened to: Multiply the head in feet by the quantity in cubic feet per second and then divide by 8.8 That is the horsepower at 100 per cent. efficiency, or the power that a perfect turbine would give."

"That efficiency isn't quite clear to me, Pop. Tell us more about it."

"Son, efficiency is the proportion of output to input, or the answer you git by dividin' the power a turbine gives by what it would give if it turned all the power of the water into work. To git the answer in per cent., you multiply that answer by 100. Now, take a very simple case. Say a turbine gives 75 horsepower and that there's 100 horsepower in the water. Dividin', you git 75 ÷ 100 = 0.75; multiply that by 100 and you have 75 per cent., which, by the way, ain't any too good. The feller said that the turbines at our new plant will give 90 per cent. at three-quarters capacity or the builders lose $5000 for each per cent. less."

"That's what I call squeezing the water till it hollers."

"Yes, Jimmy, but it'll save your Uncle Sammy a whole lot of coal. That feller last night said it takes nearly half a car of coal a year to make one horsepower in that time. Our turbines will have a capacity of 10,000 hp., so that saves about 5000 cars of coal a year."

"Now, Pop, what would that constant in his horsepower formula be for 90 per cent. efficiency? I suppose it's different from that at 100 per cent."

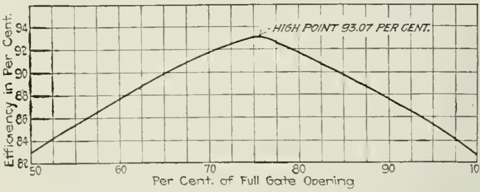
"It is different, Jimmy. I figured out a table for the different efficiencies. Here it is."

TABLE OF CONSTANTS FOR DIFFERENT EFFICIENCIES

Efficiency, Per Cent.	Constant	Efficiency, Per Cent.	Constant	Efficiency, Per Cent	Constant
74	11 9	84	10 5	94	9.36
76	11 6	86	10 2	96	9 17
78	11 3	88	10 0	98	8 97
80	11 0	90	9 77	100	8 81
82	10 7	92	9 57		

"That's fine!" declared Jimmy. "Now, what I want to know is, do these water turbines have the same efficiency at all loads or is it a case like that old steam turbine down in plant No. 1? She eats up steam like a sieve at light loads, but the steam consumption is less when the full load comes on."

"Yes, Jimmy, it's about the same thing. I ast the feller if he had any efficiency curves with him, and he said he had one. It's from a turbine that broke the record for high efficiency. Here it is; you see the high point of the curve is at 93.07 per cent. at three-quarters gate."



RELATION OF EFFICIENCY TO AMOUNT OF GATE OPENING

"What does 'gate' mean?" Jimmy asked.

"Why, that means the gates of the turbine were only open three-quarters of the full amount; that is, the gates that let the water into the turbine wheel. Corresponds to the throttle valve on a steam turbine."

"That's blame near as high as the generator efficiencies, Pop."

"You said it!" With that Pop dumped the ashes from his pipe and started off. But he came back in a minute. "Say, Jimmy," he cautioned, "the next lecture's about how they measure the stream flow of the river, the head and how they find the sizes of the turbines. See you don't miss it."

Unsafe Working Conditions

The United States Circuit Court of Appeals, First Circuit, has affirmed judgment in favor of the plaintiff in the case of Gagne vs. Burgess Sulphite Fibre Co., 255 *Federal Reporter*, 872, on account of injuries sustained by plaintiff while entering a boiler room, due to his ignorance of the fact that the stairway which ordinarily formed a means of ingress to the room had been removed.

The plaintiff, although chief engineer of defendant's plant, did not know that the stairway was so constructed as to be portable, for convenience in removing ashes accumulating in the place.

The court holds that it was open to the jury to find "that the defendant was at fault in failing to provide permanent steps, or, in case they were to be removed, in failing to establish reasonable regulations for the safety of its employees; that the plaintiff was not at fault and did not assume the risk."

It was further decided that negligence of a coemployee of plaintiff's might have contributed to the accident, by removing the steps, but that fact would not relieve defendant from liability for negligence in the particulars stated in the last paragraph.

Finding the Efficiency Ratio

By H. L. Doolittle*

In these days of constantly changing conditions of pressure and superheat in steam-turbine practice it is interesting and instructive to have some common basis on which to compare the performance of various machines. The best method of accomplishing this is by means of the so called "efficiency ratio," or the ratio of the efficiency of a perfect engine, operating on the Rankine cycle, to that of the actual turbine. It will be remembered that the Rankine cycle considers the steam as expanding from the initial pressure adiabatically to the condenser pressure.

If, then, we compare the amount of work actually obtained from a pound of steam with what would have been obtained from a pound of steam expanding in a perfect turbine, we shall have the true measure of the performance of the turbine as compared to the perfect engine. For example, suppose a turbine to be delivering one kilowatt-hour with a steam consumption of 11 lb., initial presure 260 lb. absolute, 200 deg. F. superheat, 28.5-in. vacuum. From a total-heat-entropy diagram it is found that the amount of heat available in one pound of steam with adiabatic expansion (constant entropy) is 412 B.t.u. Hence, with a steam consumption of 11 lb. per kw.-hr. there will be available $412 \times 11 = 4532$ B.t.u. per kw.-hr. As the heat equivalent of one kw.-hr. is 3412 B.t.u., the ratio of the heat equivalent of the work delivered to the heat available is $3412 \div 4532 = 75$ per cent. +. This shows that the turbine is transforming into useful work 75 per cent. of the heat available or is delivering 75 per cent. as much power as would be delivered by a perfect turbine operating under the same conditions.

The accompanying chart greatly simplifies the work of determining the "efficiency ratio." It is in reality a portion of a total-heat-entropy chart with curves superimposed thereon showing the steam consumption per kw.-hr. To use the chart, the vertical distance from the intersection of the curves of absolute pressure and superheat to the curve representing vacuum is taken off with a pair of dividers or on a piece of paper. This distance, representing the heat drop (or heat available per pound of steam between initial and final pressures), is then laid off on the B.t.u. per pound of steam scale upward from the point *A* at the lower left-hand corner. By reading horizontally to the right from the B.t.u. available to the curve giving pounds of steam per kw.-hr. the "efficiency ratio" will be found directly below on the bottom scale.

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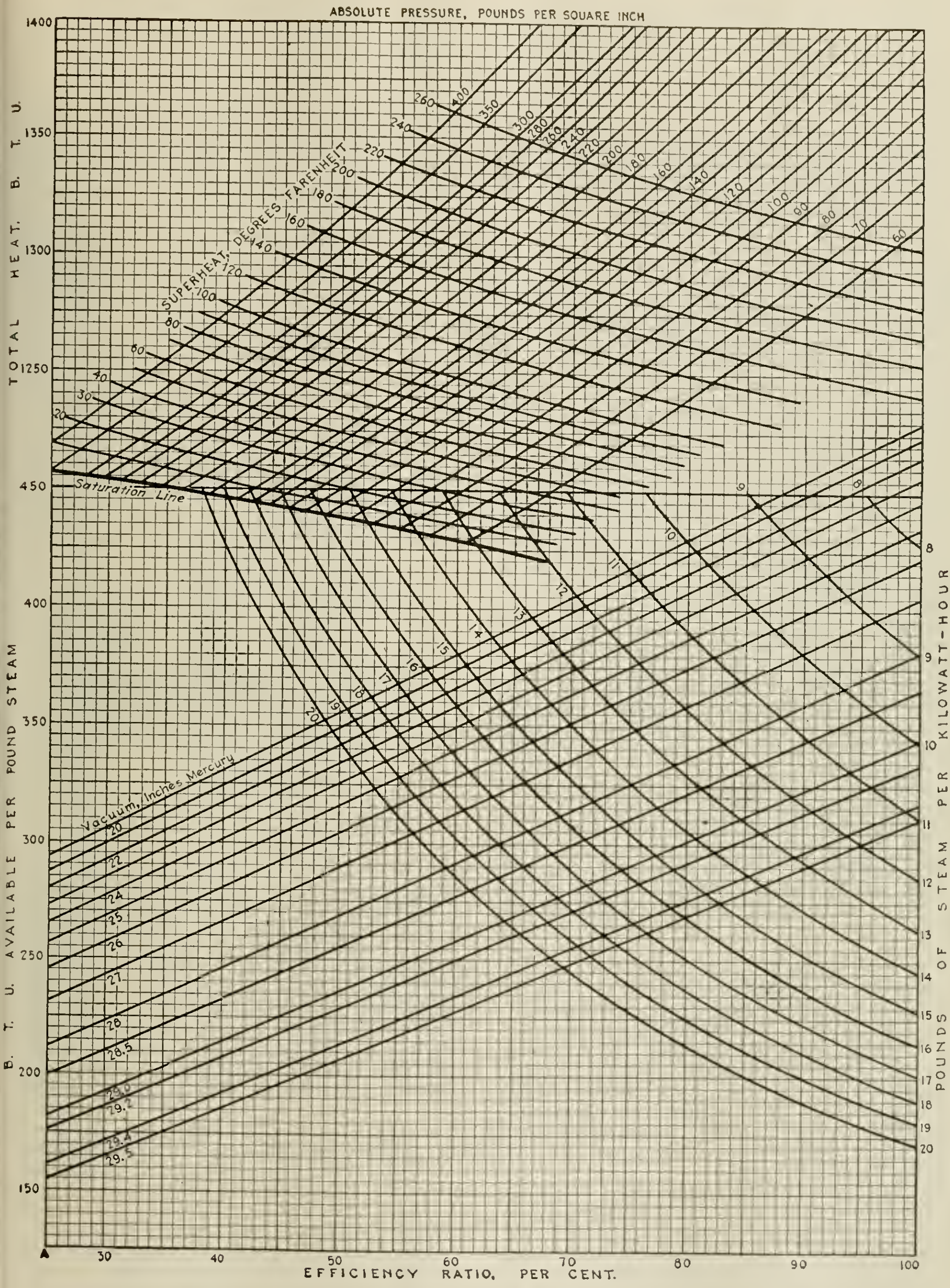
*Assistant Construction Engineer, Southern California Edison Co.



EFFICIENCY-RATIO CHART, CONSISTING OF A PORTION OF A TOTAL-HEAT-ENTROPY CHART WITH CURVES SUPERIMPOSED THEREON SHOWING THE STEAM CONSUMPTION PER KILOWATT-HOUR

Watch the Ammonia Receiver

By JOHN E. STARR

Consulting Engineer, Starr Engineering Company, New York City

The level of liquid in the ammonia receiver is one of the things essential to the successful and efficient operation of the refrigerating plant. Feed only liquid to the expansion coils; but do not judge how well or poorly it is feeding by the sound it makes passing the expansion valve.

IT IS probable that much is said here that is an old story to the operating engineer, skilled in refrigeration. But as we progress in the art, our minds are so likely to be occupied with problems immediately present and imminent, that we forget, momentarily at least, the full significance of simple first principles. This seems to be especially so in refrigerating processes, which include the study of a relation of the large number of variables, always present in heat transfers by themselves, and in the changing of heat into power and vice versa. The average engineer is familiar with the operation of the solid, liquid and gaseous states of water. That is to say, he quickly grasps the behavior of that substance in its solid, liquid and gaseous states, ice water and steam; and many are acquainted with its state as superheated steam.

It seems well, then, in handling more volatile liquids, as ammonia (NH_3), CO_2 and SO_2, to regard them as we do steam except that they have lower boiling points, and to cling to this analogy. Let us get it into our heads that refrigeration is the reverse of steam heating and keep to this idea, and at once many of the apparent difficulties disappear.

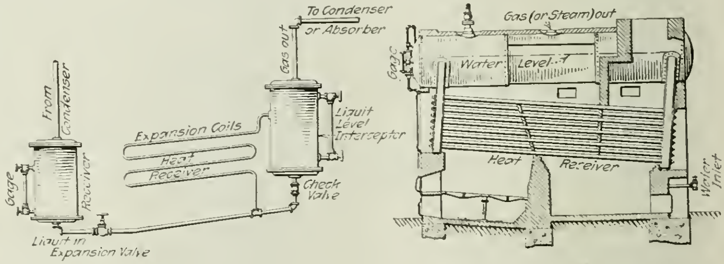


FIG. 1. COMPARISON OF STEAM BOILER AND REFRIGERATING SYSTEM

Keep in view that in steam heating we take a liquid (water) and by adding heat to it we produce a gas (steam) which we convey to a cool place, and by condensing it (as in radiators) we give out heat or warm that place; or by condensing it and so reducing its volume to water volume, or allowing it to escape to a lower pressure, we produce power, and in so condensing it we bring it back to water and repeat the process.

In refrigeration we take a liquid (say anhydrous ammonia, or NH_3) introduce it into a warm place (warmer than the boiling point of the NH_3) and *take up heat*, changing the liquid to a gas. By adding heat to this gas in the shape of power, we put it into a condition where heat can be taken out of it by the condensing water and so reduce the gas to liquid, and repeat the process.

In a sense, therefore, the expansion coils may be likened to a steam radiator *reversed*. In a broader sense, where large quantities are handled, the expansion piping may be likened to a steam boiler, and the analogy is a little closer if likened to a water-tube boiler.

If you took a glass two-thirds full of water surrounded by atmosphere and applied heat to bring its temperature to 212 deg., or over, you would expect it to boil and finally "boil away" into a gas (steam). You would expect that about all the heat would go into the water and that you could not add much heat to the *steam*. That is to say, if the upper part of the glass was the same temperature as the lower part—212 deg. F.—then the upper part would be at the same temperature as the lower part.

Now, take the same glass and pour it slowly two-thirds full of anhydrous ammonia. Surround it with a temperature of 28.6 deg. F. below zero. It will boil from a liquid to a gas just the same as water did, and the whole glass will be at —28.6 deg. F. But suppose you surround the glass with a temperature of say 70 above zero. The lower part of the glass, or up to and a little above the liquid level, will still be —28.6 deg. below zero and will accumulate frost on the outside, because it freezes the moisture in the air; but from a little above the liquid level there is no frost, and the glass, while at a little below temperature of the surrounding air (70 deg.) is not frosted. Why? Because although the gas left the surface of the liquid at —28.6 deg., it became rapidly warmed by the surrounding air at 70 deg. and soon above the liquid level the gas received enough heat through the glass from the air to warm it from —28.6 deg. to above 32 deg. or freezing, and no frost appeared near the top of the glass.

A little heat warms up a lot of gas from —28.6 to 32 deg. while the same amount of heat will boil off some liquid ammonia *at* —28.6 deg. Therefore, wherever the heat goes into the *liquid*, the temperature is —28.6 deg. at atmospheric pressure; and where the heat goes into the *gas*, the temperature is above —28.6 deg., or somewhere between —28.6 and the temperature of the surrounding air, +70 deg. in this case. A short distance above the liquid it rises to above 32 deg. and no frost appears.

Fig. 2 shows about what you would see if you put liquid ammonia into a glass exposed to the atmosphere at 70 deg. F. The ammonia when first dropped into the glass will show below —28.6 deg. because some of it has been "absorbed" or mixed with air and cooled the balance below its boiling point. It will then rise to —28.6 deg. if it is pure, and remain at that point as long as a drop remains. Frost will appear wherever the liquid touches. Shortly above the liquid level the gas would show progressively warmer, and just above the level it would show above 32 deg. and the moisture in the air would not freeze on the outside of the glass.

It is now fairly plain why you would not apply fire *above* instead of below the water line of your boiler. No steam would be made. If you did apply some heat below the water line and some above, all that the heat applied *above* would do would be to superheat the steam and you could get only a small amount of heat through a square foot of steam space surface, while you could get a large amount through a square foot of water-wetted surface, for in the latter case you would be changing a liquid to a gas (great increase in volume) while in the former you would only slightly increase the volume at the same pressure. If you filled the glass with ammonia gas instead of liquid, it is plain that you would not get much refrigeration. So we come to the point.

Look after the receiver and be sure you are feeding only liquid, and no gas to the expansion coils.

You can be sure of this only by looking at the gage-glass on the receiver and being sure that the liquid is always in sight and the expansion valve always flooded; also see that little or no heat is added to the pipe between the receiver and the expansion valve. Do not go by "sound" at the expansion valve. The writer can testify that after listening to expansion valves off and on for 30 years he cannot tell by the "sound" whether nothing but liquid is going through or whether 10 or 15 per cent. of gas is mixed with it.

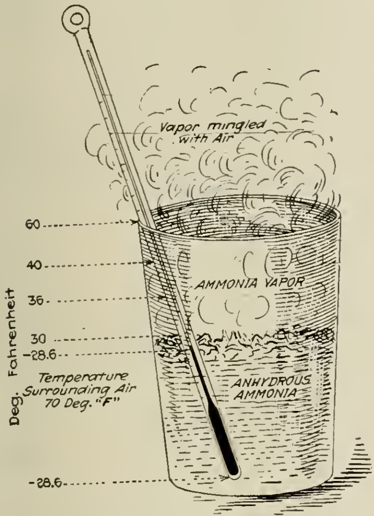


FIG. 2. BOILING LIQUID AMMONIA

An instance is recalled in Texas where an operating engineer had for 12 years allowed 10 to 30 per cent. of gas to go through with the liquid because his gage-glass was shut off and he was operating the valve by "sound." The loss in coal represented $43,800 in the period.

The similarity of a well-designed evaporating ammonia system to a water-tube boiler is illustrated in Fig. 1.

In case of ammonia the heat is received into the evaporating coils, which are full of boiling liquid. The "interceptor" catches any liquid that may "slop over" or be temporarily projected forward mechanically and keeps coils full all the time.

Any irregularity in feed is corrected by the "interceptor," and the liquid is returned to the expansion coils. If liquid is always in sight in the receiver and at about the same height (slightly above the level of the top expansion coil), the system is doing all it can.

So if water is supplied steadily at the feed pipe and kept at the same level in the gage-glass of the drum the steam boiler is doing all it can if in both cases the pipes are clean.

The "disengaging" surface (where gas leaves liquid) in both cases must be ample or the liquid will "foam" or be carried forward to either the compressor or absorber in the case of ammonia or to the engine or heater in the case of steam, where it will do no work and may do harm.

The check valve prevents the gas blowing both ways and insures a coil full of liquid. Some prefer to feed into the top of the interceptor and so allow the gas formed to cool the liquid from condenser temperature to evaporator temperature and pass directly to the compressor. This gas, usually 15 per cent. to 18 per cent. by weight, does not mix with gas formed in the coils. The coils are therefore a little more effective per square foot, as the liquid contains less gas and more liquid-wetted surface per square foot of pipe surface.

It is obvious that we would not want to apply heat only at the interceptor, so we insulate it. Neither would we want to apply a fire *only* above the water-line of the steam boiler.

Now, the importance of watching the gage-glass of the receiver is plain, for although the liquid level in the interceptor may be constant, in a pipe system the liquid may be "shoved ahead" by gas and the first part of the system may contain a large proportion of gas and be less effective.

Any of the fluid that passes the expansion valve as a gas does no good, and work, as we shall see, has to be expended on it just the same as if it passed as a liquid.

So the message cannot be too often reiterated—watch the receiver.

A careful tabulation of all the lapses in 32 plants under one management revealed that 89.4 per cent. of all troubles lay in feeding gas through the expansion valve. Were it not for this large percentage, there would have been some hesitation in mentioning so obvious a matter. It is close attention to a few things in a refrigeration plant which means success and continuous service.

Accidents Caused by Unguarded Shafts

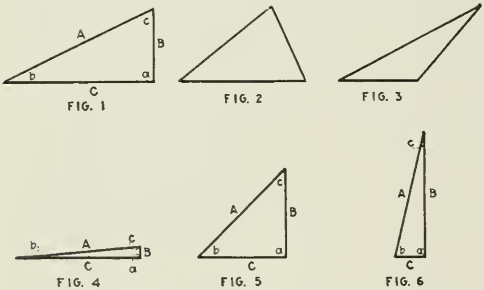
Affirming an award of $5000 for the death of an engineer employed at a mine, resulting from his clothing catching on an unguarded portion of a shaft which extended beyond the engine house, the Pennsylvania Supreme Court holds in the case of Carley vs. Dexcar Coal Mining Co., 105 Atlantic Reporter, 651, that decedent was not to be regarded as having been guilty of contributory negligence in passing that particular place. Although he knew the surrounding conditions, it afforded him the only means of ingress to and egress from his place of work.

It is further decided that under the statutes of Pennsylvania requiring dangerous machinery and shafting to be safeguarded, an employee is not to be regarded as assuming the risk of being injured through the condition of shafting left unguarded, although the peril may be obvious.

The Electrical Study Course—Relations Between the Sides of a Right-Angle Triangle

A simple explanation is given of what the terms sine and cosine are and how they are applied to find the length of the sides of a right triangle.

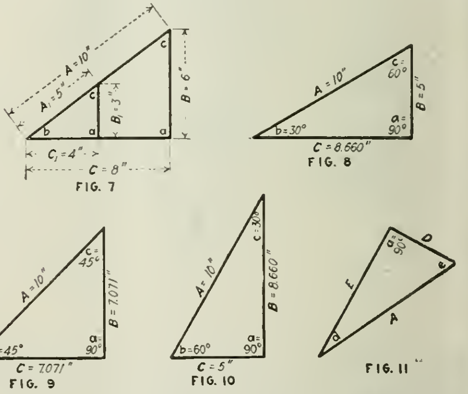
IN DEALING with alternating current the term "sine curve" is frequently met with. Also the word "cosine," especially in regard to power factor, is a common term. To understand what is meant by "sine" and "cosine," it is necessary to give attention to certain relations that exist in right-angle triangles. Right-angle triangles are triangles that contain an angle of 90 deg., as shown at *a* in Fig. 1, in contradistinction to those that do not have, as for instance such triangles as those indicated in Figs. 2 and 3.



FIGS. 1 TO 6. TRIANGLES OF DIFFERENT SHAPES

It is evident that right-angle triangles may be of a variety of shapes, ranging from a very small to a very large angle at *b*, as illustrated in Figs. 4 to 6. For each possible shape, the lengths of the sides *A*, *B* and *C* are always in the same proportion, whether the triangle be a small one or a large one. Thus, in Fig. 7 we have two triangles, *A B C* and A_1 B_1 C_1, whose shapes are identical, but one of which is larger than the other. The angle *b* is 36.87 deg., and for a triangle of that shape the sides would be in the proportions shown. That is, if *A* is made 10 in., *B* will be 6 in. and *C* will be 8 in. If *A* is cut in half, then both *B* and *C* must be cut in half if the shape is not to be changed. This is shown by the smaller triangle A_1 B_1 C_1, whose sides are 5 in., 3 in. and 4 in. respectively. It will be noticed that the proportion of the sides is the same in both cases. Thus, $\frac{B}{A} = \frac{6}{10} = 0.6$, and $\frac{B_1}{A_1} = \frac{3}{5} = 0.6$; or $\frac{C}{A} = \frac{8}{10} = 0.8$, and $\frac{C_1}{A_1} = \frac{4}{5} = 0.8$, etc. It is therefore apparent that so long as *b* is 36.87 degrees, the values of the fractions $\frac{B}{A}$, $\frac{C}{A}$, etc., will remain the same, irrespective of how long or short the sides of the triangle may be. As already stated, each shape of triangle has its own particular values. For example, when *b* is made 20 deg., $\frac{B}{A} = 0.3420$ and $\frac{C}{A} = 0.9396$; and when it is made 50 degrees, $\frac{B}{A} = 0.7660$ and $\frac{C}{A} = 0.6427$, and so on.

The value of the fraction $\frac{B}{A}$ is called the sine of the angle *b*, and that of the fraction $\frac{C}{A}$ its cosine. These terms are abbreviated "sin" and "cos" respectively. From the foregoing it is evident that the following is true: Sin 36.87 deg. = 0.6, cos 36.87 deg. = 0.8, sin 20 deg. = 0.3420, cos 20 deg. = 0.9396, sin 50 deg. = 0.7660, and cos 50 deg. = 0.6428. The values of the sines and cosines for all values of *b* were many years ago carefully computed and are available in tabular form in various books. The accompanying table gives their value for every angle from zero to 90 deg. It is evident that 90 deg. is the limit, for as *b* increases from a small angle, as in Fig. 4, to a larger one, as in Fig. 5, the side *C* becomes shorter, and as the increase continues it becomes still shorter, as for instance in Fig. 6. The angle *b* would become bigger and bigger, and *C* shorter and shorter, until *b* became almost 90 deg. At the instant it did actually become 90 deg., *C* would disappear and *A* would be identical with *B*, after which it would be impossible to increase the angle any further.



FIGS. 7 TO 11. SHOW THE RELATION BETWEEN THE SIDES OF DIFFERENT RIGHT TRIANGLES

Since at 90 deg. *B* is equal to *A*, and *C* is zero, it follows that sin 90 deg. $= \frac{B}{A} = 1$, and cos 90 deg. $= \frac{0}{A} = 0$, the values given in the table. A similar analysis of the conditions when the angle *b* approaches zero, as in Fig. 4, will show that when it does actually become zero, *B* will disappear, and *A* will coincide with *C*, from which we have that sin 0 deg. $= \frac{0}{A} = 0$, and that cos 0 deg. $= \frac{C}{A} = 1$, which values also agree with those given in the table. By means of the table the value of the sine or cosine of any other angle can be determined, or knowing the value of a sine or cosine, the corresponding angle can be found.

In addition to the relation between the sides of a right-angle triangle discussed in the foregoing, there is another one of importance, which is, that the square of the side A is always equal to the square of B plus the square of C. That is, $A^2 = B^2 + C^2$. Thus, in Fig. 7, $A^2 = 10^2 = 100$, and $B^2 + C^2 = 6^2 + 8^2 = 100$; or $A_1^2 = 5^2 = 25$, and $B_1^2 + C_1^2 = 3^2 + 4^2 = 25$. The same relation would be found to hold true, no matter what the size and shape of the right-angle triangle; hence we have a ready means of determining the length of the third side of a right triangle if the lengths of two of the sides are known, as often happens.

There is yet one other property of right triangles that is to be noted, which is, that the angle b plus the angle c is always equal to 90 deg., no matter what the shape of the triangle. For example, in Fig. 7, c would be equal to 90 deg. — 36.87 deg. = 53.13 deg. Hence, if either b or c is known, the value of the other can be found by subtracting the known angle from 90 deg.

In order to illustrate the various relations treated of, their values will be determined in the case of a few typical examples. Figs. 8, 9 and 10 represent three right-angle triangles in which the angle b is 30, 45 and 60 deg. respectively. In each case the side A is supposed to be equal to 10. In Fig. 8 angle $c = 90 - 30 = 60$ deg., in Fig. 9 c equals $90 - 45 = 45$ deg., and in Fig. 10 it equals $90 - 60 = 30$ deg. In any right-angle triangle the side B equals side A times sin b, and the side C equals the side A times cos b. Now, if we know A to equal 10 in., from the table we find sin b, which in this case is sin 30 deg., equals 0.5000 and cos $b = 0.8660$, from which $B = 10 \times 0.5000 = 5$ in. and $C = 10 \times 0.8660 = 8.660$ in., as shown in the Fig. 8. To check the results we may add B^2 and C^2, which should equal A^2. Doing so, we have $A^2 = B^2 + C^2 = 5^2 + (8.660)^2 = (5 \times 5) + (8.660 \times 8.660) = 100$, from which $A = \sqrt{100} = 10$, therefore values are correct.

NATURAL SINES AND COSINES

Angle	Sine	Cosine	Angle	Sine	Cosine	Angle	Sine	Cosine
0	0.0000	1.0000	31	0.5150	0.8572	61	0.8746	0.4848
1	0.0174	0.9998	32	0.5299	0.8481	62	0.8803	0.4695
2	0.0349	0.9994	33	0.5446	0.8387	63	0.8910	0.4540
3	0.0523	0.9986	34	0.5592	0.8290	64	0.8988	0.4348
4	0.0698	0.9976	35	0.5736	0.8192	65	0.9063	0.4226
5	0.0872	0.9962	36	0.5878	0.8090	66	0.9136	0.4067
6	0.1045	0.9945	37	0.6018	0.7986	67	0.9205	0.3907
7	0.1219	0.9926	38	0.6157	0.7880	68	0.9272	0.3746
8	0.1391	0.9903	39	0.6293	0.7771	69	0.9336	0.3584
9	0.1564	0.9877	40	0.6428	0.7660	70	0.9397	0.3420
10	0.1737	0.9848	41	0.6561	0.7547	71	0.9455	0.3256
11	0.1908	0.9816	42	0.6691	0.7431	72	0.9511	0.3090
12	0.2079	0.9782	43	0.6820	0.7314	73	0.9563	0.2924
13	0.2250	0.9744	44	0.6947	0.7193	74	0.9613	0.2756
14	0.2419	0.9703	45	0.7071	0.7071	75	0.9659	0.2588
15	0.2588	0.9659	46	0.7193	0.6947	76	0.9703	0.2419
16	0.2756	0.9613	47	0.7314	0.6820	77	0.9744	0.2250
17	0.2924	0.9563	48	0.7431	0.6691	78	0.9782	0.2079
18	0.3090	0.9511	49	0.7547	0.6561	79	0.9816	0.1908
19	0.3256	0.9456	50	0.7660	0.6428	80	0.9848	0.1737
20	0.3420	0.9396	51	0.7771	0.6293	81	0.9877	0.1564
21	0.3584	0.9336	52	0.7880	0.6157	82	0.9903	0.1392
22	0.3746	0.9272	53	0.7986	0.6018	83	0.9926	0.1219
23	0.3907	0.9205	54	0.8090	0.5878	84	0.9945	0.1045
24	0.4067	0.9136	55	0.8192	0.5736	85	0.9962	0.0872
25	0.4226	0.9063	56	0.8290	0.5592	86	0.9976	0.0698
26	0.4384	0.8988	57	0.8387	0.5446	87	0.9986	0.0523
27	0.4540	0.8910	58	0.8481	0.5299	88	0.9994	0.0349
28	0.4695	0.8830	59	0.8572	0.5150	89	0.9998	0.0174
29	0.4848	0.8746	60	0.8660	0.5000	90	1.0000	0.0000
30	0.5000	0.8660						

Following a similar course for Figs. 9 and 10, we find from the table that sin 45 deg. = 0.7071 and cos 45 deg. has the same value, also sin 60 deg. = 0.8660 and cos 60 deg. = 0.5000. Then in Fig. 9, $B = A \sin b = 10 \times 0.7071 = 7.071$ in., and $C = A \cos b = 10 \times 0.7071 = 7.071$ in.; also in Fig. 10, $B = A \sin b = 10 \times 0.8660 = 8.660$ in., and $C = \cos b = 10 \times 0.5 = 5$ in.

Inspection of Figs. 8 and 10 will show that really only one of them would have been required, since each has a 30-deg. and a 60-deg. angle. Thus, if Fig. 8 were cut out with a pair of shears and pasted directly over Fig. 10, it would exactly cover it. Hence, in Fig. 8, sin 60 deg. would be $\frac{C}{A}$, and cos 60 deg. would be $\frac{B}{A}$. The point that this brings out is that although it is most convenient to represent the angle in the lower left-hand corner as b in Figs. 1 to 10, it is not essential to do so. For example, we might show a triangle in the position illustrated in Fig. 11. Then $\sin d = \frac{D}{A}$, $\cos d = \frac{E}{A}$, $\sin e = \frac{E}{A}$, and $\cos e = \frac{D}{A}$.

When we say that the alternating voltage induced in an armature varies according to a sine curve, we mean that the distances above and below the xy line are equal to the sine of the angle through which the armature has turned. This will be presented at greater length in the next lesson.

The problem of the preceding lesson consisted of finding the efficiency of a generator that was driven by a motor, when the load carried by the generator is 225 amperes at 117 volts and the current taken by the motor is 73 amperes at 550 volts, provided it is known that the efficiency of the motor at the given load is 82 per cent. The watts input to the motor is equal to its voltage times its current, so that if P_m represent the input, we have, $P_m = 550 \times 73 = 40{,}150$ watts. Since the efficiency at this load is 82 per cent., the output must be equal to the input multiplied by 0.82. If P be made to represent the motor output, we therefore have, $P = 0.82 \times P_m = 0.82 \times 40{,}150 = 32{,}923$ watts. In this case P is not only the output of the motor; it is also the input of the generator. The output of the generator, on the other hand, is equal to its voltage times its current. If P_g is used to represent the generator output, we have that $P_g = 117 \times 225 = 26{,}325$ watts. The efficiency of any machine being its output divided by its input, in this case $\frac{P_g}{P}$, we find that the efficiency of the generator at the load specified is $\frac{P_g}{P} = \frac{26{,}325}{32{,}923} = 0.7996$, which, multiplied by 100 to convert it into per cent., gives $0.7996 \times 100 = 79.96$ per cent.

The lower end of a 20-ft. ladder is placed 5.1764 ft. from the wall of a building. How far up the wall will the ladder reach? What angle will it make with the ground? What angle with the wall?

Up to five or six years ago, commercial gas compression plants consisted of the simplest forms of gas pumps, single-stage compressors, and cooling coils. The plants operated only on rich casing-head gas that would produce four to six gallons of condensate with a capacity of not more than 200,000 or 300,000 cubic feet daily. At present plants are in operation treating from 6,000,000 to 9,000,000 cubic feet of gas daily, yielding as low as one gallon of condensate per 1,000 cu.ft., using pressures of 250 and 300 lb. per sq.in. in two stages of compression, with elaborate systems of cooling the gas with water before compression and after each stage of compression. In some plants the gas is further cooled—temperatures as low as 0 deg. F. are often obtained, causing the precipitation of nearly all the condensable fractions commercially valuable for making gasoline.

Flue-Gas Analysis and Co_2 Recorders

By B. M. Baxter

That the CO_2 recorder as a guide to boiler operation and to the prevention of fuel losses is a valuable instrument when its records are properly interpreted and applied, is not open to argument. Nevertheless, it is a desirable apparatus only because we have, as yet, nothing better.

At first thought this may seem a rather radical statement, but let us consider what condition we are seeking to control by the use of the CO_2 recorder. To get a high average percentage of CO_2 in the flue gases, of course. But why?

The idea of maintaining a high CO_2 figure has been so drilled into the minds of power-plant engineers that in many cases the reason for so doing has been lost sight of or forgotten. Taking as a basis the fact that atmospheric air contains roughly 21 per cent. oxygen and 79 per cent. nitrogen (which takes no part in combustion) and that when combustion occurs, the CO_2 resulting occupies the same volume as the oxygen entering into CO_2, it is evident that the sum of the percentages of CO_2 and oxygen should be 21. This is assuming that no carbon monoxide is formed as a result of incomplete combustion. Therefore as the percentage of CO_2 increases, the percentage of oxygen (excess air) must decrease, and it is the excess air which we strive to keep to a minimum.

Influence of Hydrogen

If the foregoing simple condition always held, there would be no fault to find with the CO_2 recorder, but it can only hold true when burning a fuel in which the combustible is all carbon. In all bituminous coals there is a proportion of hydrogen, and it is this which makes the CO_2 recorder of less value than generally supposed. When the hydrogen is consumed. water vapor is formed and in the flue-gas analysis disappears. Instead of a total of 21 for the sum of the percentages of CO_2 and oxygen, in practice the sum may be anywhere from 17 to 20.5, the difference between the figure obtained and the original total of oxygen being the amount of oxygen that has combined with hydrogen in the coal and disappeared as far as the flue-gas analysis is concerned.

The figure for the total of CO_2 and oxygen will vary according to the condition of the fire when the gas sample is taken, and it will be lower if taken just after firing and higher if the fire is well coked. It will also vary according to the amount of CO_2 contained and will be higher for low percentages of CO_2 and lower as the percentage of CO_2 increases.

This is the reason why the record of the CO_2 recorder is misleading. For example, if the recorder was being checked with an Orsat apparatus, we might make an analysis with a result as follows: CO_2, 12.0; O_2 (oxygen), 8.0; CO (carbon monoxide), 0.0; total, 20.0

As soon as this analysis is completed, we might draw another sample and get this result: CO_2 12.0; O_2, 5.0; CO, 0.0; total, 17.0.

In both these assumed analyses, which would be not at all exceptional in actual practice, the CO_2 recorder would show 12 per cent., and we would have no reason to assume otherwise than that the combustion conditions were the same. Yet in one case twelve-twentieths of the oxygen was used in combustion and there was an excess of 40 per cent. and in the other case twelve-seventeenths was used, so that the excess of air was about 29 per cent. The efficiency of combustion is materially different in the two cases.

Oxygen Recorders Are Needed

We need then, not CO_2 recorders but oxygen recorders, for we care nothing about what the percentage of CO_2 is, except only as it indicates by difference the percentage of oxygen, or, in other words, excess air.

Admitting that this is true, why do we have no oxygen recorders? Presumably because there is known no solution by which the amount of oxygen in the flue gas can be determined without first removing the CO_2, for the solution now used for the determination of oxygen (pyrogallic acid in caustic potash) will also absorb CO_2 and hence the CO_2 must first be removed. It is a problem to put to our chemists to develop such a solution, which will be sufficiently rapid in action to be practicable and can be obtained at as low cost and require no more frequent renewal than the caustic-potash solution now used for the determination of CO_2. If such a solution can be produced, our present CO_2 recorders can immediately be converted into oxygen recorders and the usefulness of their records greatly increased. aside from the inaccuracies of the present recorders as a means to determine excess air.

Owing to the inability of the CO_2 recorder to indicate with even an approximate degree of accuracy the amount of excess air, there is great danger while striving to reduce the furnace losses caused by excess air, to get insufficient air and produce CO in appreciable quantities. The loss resulting from the production of even small amounts of CO may easily overbalance the saving resulting from the attainment of high average CO_2, or, more properly speaking, the reduction in excess air indicated by high CO_2. For each pound of carbon burned to CO there is a loss of about 10,000 B.t.u., hence even small amounts of CO are ruinous to boiler economy.

With the CO_2 recorder there is no means to detect the presence of CO in the furnace gases except that in a properly designed furnace there should be no CO formed except with very small amounts of surplus oxygen. The point at which CO will begin to appear depends on the volume of combustion space and the mixing of the gases in the combustion space. Because of the variation in the amount of excess oxygen that goes undetected by the CO_2 recorder, this instrument is particularly lacking in this respect, and an oxygen recorder would be vastly better as it would indicate without any guesswork just what amount of oxygen was present. Checking with an Orsat apparatus would readily indicate how much the amount of excess oxygen could be safely reduced without the formation of CO.

Effect of Leakage of Air on Reliability of CO_2 Recorders

Another factor greatly affecting the reliability of CO_2 recorders as guides to furnace conditions (and this applies in some measure to Orsat analyses as well) is the influence on the composition of the flue gas of the leakage of air into the boiler setting.

This was strikingly illustrated by analyses made during some evaporation tests conducted by the writer on a water-tube boiler, in which the gases made a single pass through the tube bank. The setting of this boiler had been examined carefully before the test and all visible air leaks stopped. The draft in the furnace averaged 0.015 in. water gage in one test and 0.003 in another, with corresponding drafts at the damper of 0.38 and 0.50 in. These low-draft conditions would tend toward minimizing the infiltration of air into the setting.

Analyses of furnace gases were made from samples taken from the rear of the combustion chamber and simultaneous samples taken below the damper. In one test the average percentage of CO_2 in the furnace gases was 13.1 and the average percentage of CO_2 in the flue gases 10.83. In the other test these figures were respectively 14.4 and 11.8.

The point to be brought out here is that there is likely to be a very considerable infiltration of air under even the best conditions.

CO_2 recorders are usually connected to draw samples of flue gases, not furnace gases. If the setting is not maintained in a condition of exceptional tightness, the records of the recorder will be no reliable index of the conditions existing in the furnace, and a low showing of CO_2 would lead to the belief that excessive amounts of excess air were passing through the furnace, and in the endeavor to correct this supposed condition the air admission might be so reduced that very considerable amounts of CO would be produced with attendant losses.

This condition could also exist with an oxygen recorder, but at least one variable would be eliminated—the undetectable variation in the amount of excess air due to the variation in the amount of volatile and other hydrocarbons consumed.

When samples for analysis are taken from the setting at or near the combustion chamber, the effect of air leaks through the setting is eliminated, but there is no indication of the pressure of such leaks. However, much more reliable indications can be had of the actual conditions of combustion, and accordingly the combustion can be controlled better. Using an Orsat for an occasional analysis of flue gases and comparing the results with the recorded analyses of furnace gases will immediately show whether attention to the setting is needed.

The use of an excess-oxygen recorder for analysis of furnace gases, with an occasional analysis for determination of setting leakage, would give an almost ideal method of determination of efficiency of combustion and a method vastly better than the present CO_2 recorder practice.

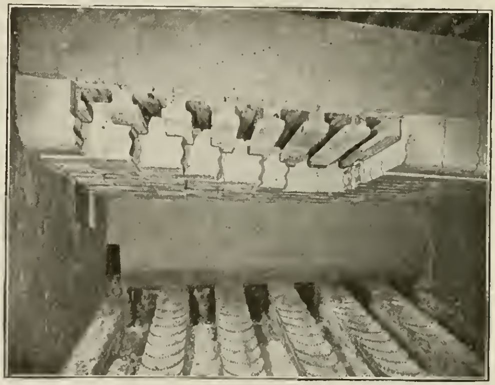
Liptak Double Suspension Arch

Owing to the high volatile and moisture content of bituminous coal the air must be heated to a temperature higher than could be attained by its passage through the fire and by absorption from the side walls. In most cases an arch is needed to ignite the coal in the first place and to maintain a furnace temperature high enough to burn the liberated gases.

The sprung arch has been superseded generally by various forms of flat suspended arches. The principal requirements are proper design, durability, ease of repair, adaptability to any width of furnace, accessibility and avoidance of an enforced shutdown of the boiler.

A new arch that appears to meet these requirements has been developed recently by the Liptak Fire-Brick Arch Co., 844 Builder's Exchange, Minneapolis, Minn. Its distinguishing characteristic is that it is a double suspension arch. This feature consists of a reserve arch over and supporting the lower arch exposed to the fire. The lower tile can be burned away without necessitating a shutdown, as the reserve arch still protects the cast-iron supporting beams and permits the boiler to continue in operation until it conveniently can be taken off the line and a new lower arch installed or the damaged blocks replaced. This is done by sliding in new blocks in grooves of the reserve arch.

At the inner end of the arch the service is more severe, and special precautions have been taken to protect the cast-iron supporting beams. Each beam is equipped with a replaceable tip, so that in the event of the extreme condition that the end blocks burn away, exposing and damaging the supporting members, it will be necessary to replace the tip only instead of the entire beam. Above the end blocks are tile supported independently, so that the lower arch may be renewed without disturbing the rear brick wall. The illustration shows the construction of the arch and the cast-iron supporting members. Between the transverse I-beams supporting the arch the cast-iron supporting members are of tee section. Under the main supports the shape changes to a modified I-beam section, the upper flanges taking the hangers from the main transverse I-beams and the lower flanges supporting the reserve arch.



SHOWING APPLICATION OF ARCH BLOCKS

An air space between the two arches permits circulation of air, helps to keep the reserve arch cool and adds to the life of the installation. Wavy line joints, with no cement, between the blocks of the primary arch prevent the flame from passing through and attacking the arch above. The blocks are made off center and in successive rows the position of the long end of the block is alternated, so as to produce staggered joints lengthwise of the arch.

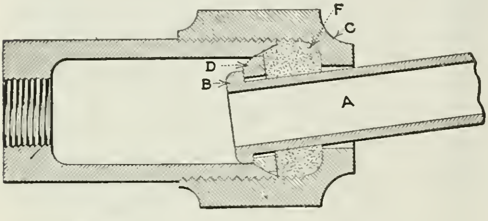
The construction is about three inches deeper than the average single arch and due to the double arch, is more expensive. Longer life and more dependable service are the advantages offered to more than offset the higher initial cost.

Thirty-three municipalities covering a territory about 75 miles in length have organized as the Associated Municipalities of Northwestern Ontario. The principal object in view is to secure electric power from the Provincial Hydro-Electric Commission. A resolution was adopted requesting the commission to proceed at once with the development of power on the Sapgeen River.

Berryman Expansion Union

This union has been designed for the purpose of taking care of expansion and contraction in pipe lines, due to variation of temperatures. It can also be used as a union or as a swivel joint, and it is not necessary to keep a pipe line in a straight line. It is patented by W. F. Berryman, Middletown, Ohio.

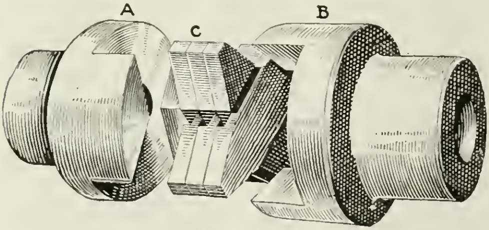
The union consists of two pipe members of different diameters, one fitting within the other as shown in the illustration, which also illustrates the angle at which a pipe line may be connected. One of the pipe sections *A* has one end provided with a flange *B*, the outer edge of which is round. Surrounding this pipe is a gland *C*. A packing ring *D*, with a rounded outer face, is provided and seats on a like surface of the casing. The flat sides of the packing ring compress a packing substance *F* when the gland *C* is screwed up tight. As the opening in the gland is larger than the pipe *A* the latter can be considerably out of line, and still maintain a tight joint.



SECTION THROUGH EXPANSION UNION

Uniflex Shaft Coupling

Each design of shaft coupling manufactured has had its own destinctive features. This holds true in the instance of the Uniflex shaft coupling, manufactured by the Uniflex Coupling Co., 246 Chestnut St., Philadelphia, Penn. The coupling comprises two shaft members *A* and *B* and a set of blocks *C*. The shaft members are made with jaws that engage each other through the blocks that fit in between the faces of the jaws. The amount of block slides varies according to the displacement of the shaft axes. When the blocks *C* are made solid, or faced with fiber, wood, rawhide, etc., the coupling is insulating, shock-absorbing and does not require lubrication. The coupling can also be made self-adjusting for wear, and it works equally well in either direction. It is relatively small and is designed for any size shaft, horsepower and speed.



COUPLINGS AND BLOCKS

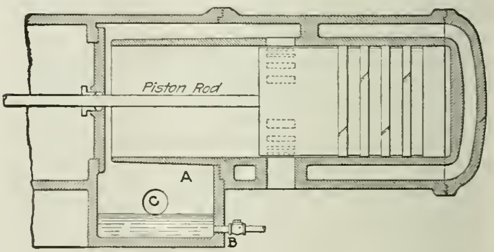
Oil Engine Smokes

By E. E. Snow

Recently the writer was called in to solve the problem of a surface-ignition or low-pressure oil engine that had a decidedly smoky exhaust. The engine was of the hot-bulb type and had the crank end of the engine cylinder inclosed. This acted as the air compressor to furnish the scavenging air to the power cylinder. The engine operated on the two-stroke cycle, and the cylinder construction followed the general lines shown in the illustration.

The first conclusion was that the fuel-pump timing was incorrect, causing the oil to be injected too late to afford complete combustion. This conclusion proved to be erroneous. The next idea was that the ignition device, which was a hot bolt assisted by a hot plate on the piston, did not reach a temperature high enough to ignite the oil. This was not the case, and the opposite stand was then taken—that the igniter was so hot that the oil cracked, depositing the heavier hydrocarbons which caused the smoke. Experiments did not bear out this contention.

Further examination revealed that the excess lubricating oil fed into the cylinder worked to the air end and dripped down into the airbox *A*. There was a plugged opening at *B* which had never been opened. The oil had filled this air passage, or box, until it was on a level with the air suction valve *C*. Thus, the air in passing through the valve picked up the oil and carried it in suspension. This air, after being compressed, blew into the power cylinder when the piston uncovered the air ports. The lubricating oil held in suspension was heated up by the exhaust gases and, as it passed out through the exhaust ports, produced black smoke. A $\frac{3}{4}$-in. drain line was run into the air passage three inches below the air valve. This drain had a check valve opening outward; the check allowed the oil to drain out and prevented the suction pressure from causing a reverse flow. Of course the open drain line caused a loss of air, but this was small and had no effect on the scavenging. The installation of the drain line caused the exhaust to clear up at once.



CYLINDER CONSTRUCTION OF THE ENGINE

Immediate steps to rehabilitate the Anderson power plant of the Union Traction Company of Indiana so that adequate and regular service can be given to the cities along the line were ordered June 13 by the Public Service Commission of Indiana. The order is the result of a complaint filed with the commission by a number of prominent business concerns of Marion, who claimed that the poor service was caused by the power plant at Anderson.

EDITORIALS

What Is the Truth About the Coal Situation?

IN AN advertisement imploring the public to buy their coal now, published recently in various daily newspapers, over the name of the National Coal Association, Commercial Bank Building, Washington, D. C., appears the very disquieting statement:

> Coal Shortage Coming—says U. S. Fuel Administration; Labor Shortage Pending—says U. S. Secretary of Labor; Car Shortage Predicted—by the Director General of Railroads. Buy Your Coal Now.

This apparently very earnest and conscientious appeal continues:

> Listen to and heed what your Government officials say. We are telling you the coal situation as we know it. Moreover, everything we are saying is based upon the official statements of the highest Government authorities.
>
> Forty thousand foreign-born miners are returning to Europe. There is virtually no immigration; consequently the men cannot be replaced. Their departure alone means a reduction of forty million tons in the coal output of the year—twenty million tons for the remainder of 1919.
>
> Government chiefs have issued warnings to buy coal now. Harry A. Garfield, United States Fuel Administrator, warns:
>
> Buy now—in August or Autumn will be too late. A big coal shortage is coming.
>
> Director General Hines, of the United States Railroad Administration, warns the coal consumer that unless he buys coal this summer he is going to find it difficult to get it this fall and winter.
>
> Secretary of Labor Wilson says: Those who postpone buying coal in the hope of lower prices are speculating in the future misfortunes of the nation.

In the New York *Evening World* of July 7 and 8, 1919, were two articles on the coal situation, purporting to be specials from a staff correspondent, that, if authentic, make Ananias look like a piker when compared with this philanthropic National Coal Association. The following are some of the statements appearing in the *Evening World:*

> Cleverly placed publicity by the coal interests declares that coal will be very scarce and the public must quickly buy or suffer the terrible consequences, because of labor shortage and like reasons.
>
> As a matter of fact there are now stacked up millions of tons of coal ready for the public to buy. In one section, Landingville, there is one pile of close to one million tons of coal ready for the public, and there are dozens of like mountains of fuel in and around the Schuylkill section.
>
> A hue and cry has been raised that the production this year is so far behind that of last year for the same period as to create a very acute situation. Figures compiled by experts show that the output this year is just about normal, as compared with previous years. Quite naturally, the production of 1919 is somewhat behind that of 1918, because there is now lacking the great incentive of war and the stupendous need for fuel for the conflict.
>
> Having raised the price of coal fifty cents a ton, at the rate of ten cents a month from April on, the coal operators insist the public should immediately buy. There is abundant proof in this section that the coal barons not only shut down their plants in April and part of May to prevent a too plentiful supply of coal and thus a cheaper market, but that a similar shutdown will occur in August. In that month the top price of the fifty-cent jump will have been reached, and the public is not expected to rush in orders. Plans are already perfected to announce then that the public is not buying enough coal to warrant mining.
>
> It is asserted by those who have always been close to mining in this section that the Governmental prices were such as to allow a more than handsome profit to the operators, and that, when fixed, these prices allowed for the raise of pay to the miners. In fixing the fifty-cent jump for this year nothing was added to the miners' pay.
>
> One of the dominant reasons for a probable coal shortage, assigned by the operators, is the labor situation. They declare that the ending of the war has resulted in thousands of miners quitting their work and rushing back to Europe to see the land of their birth. Local officials hereabouts have yet to find one single case of a foreigner leaving his work in the mines to return to Europe.
>
> The claim is made by operators that labor is scarce and that returning soldiers, formerly miners with plenty of experience, have declined to again go down in the mines. Not only is this assertion strenuously contradicted, but plenty of proof exists to show that many returning soldiers have been deliberately turned down when they applied for their old tasks.

Which of the two stories is true? It is evident that both are not, for they are diametrically opposite. If the statements in the advertisement are not correct, are we to believe that members of the President's Cabinet, men occupying positions that rank next to the chief executive of this country, are allowing their names to be used by the coal operators to extort the public. On the other hand, if the truth of the situation is presented by the National Coal Association, is it possible that a great newspaper like the New York *Evening World* can distort facts and cause the statements of some of the country's highest public officials to be open to question, without being brought to account? However, be as it may, if the coal operators had been sincere in wanting to encourage the consumer to purchase coal early, one of the best inducements would have been to reduce the price last April, as in former years, and gradually increase it to normal during the summer months, and save the expense of advertising at the present time. One of the best ways to discourage early buying is the boosting of prices, and this is what was done and production cut down about fifty per cent. so as to delay the purchase of coal until such time as the highest prices could be extorted from the consumer.

Determining Loads with a Graphic Ammeter

DURING recent years the records obtained from graphic meters have become an important factor in the efficient management of many power plants and industrial concerns. Although their principal use is in actual measurement of certain quantities with respect to time, yet a careful analysis of a graphic record will reveal a great many details of the performance of workmen and machines. For instance, assume a graphic instrument to be connected in the circuit of a motor which runs a milling machine, producing a standardized product. Naturally, the record will show at what time the motor was started and stopped; it will show the power consumed at no load and when loaded. This is valuable information, but the record shows more than this: It tells when the workman started to work; how many cuts he made; the time of each cut and the period between each. It tells if a heavy cut or a light one was made; whether the machine was jammed and the time the operator quits work and whether the motor was stopped or not.

Settling disputes between the customer and the power company is another important duty of the graphic. In fact, the graphic frequently prevents disputes, since the clearness of its authentic record leaves no ground for dispute. A lighting company supplies power to a city's arc lamps, and the municipal authorities make a claim that the lamps were not lighted at certain periods when they should be, and claim a rebate. The company may be equally confident that they were lighted. The expensive calling of witnesses on both sides can be avoided if either side can produce a continuous graphic record to substantiate its claim—the other side could not well dispute the record.

Other uses are in determining maximum demands and the time of their occurrence; locating leaks and theft of current; locating the use of current at unexpected hours and at unnecessary times; determining loads for the addition or rearrangement of motors for more efficient operation; and, in fact, a multitude of uses which constantly present themselves to the alert engineer.

The instruments generally used for this purpose have in the past been heavy, semiportable graphics, usually graphic wattmeters, and their great expense, both initial and in setting up, has greatly discouraged their use except when permanently installed on important circuits. However, there are now available sturdy portable graphic ammeters, which are light, low in cost and easily transferred from one location to another and connected into the circuit without interruption of the service. Of course the results obtained are hardly accurate enough to base the actual power consumption on, nevertheless these graphics produce a wealth of valuable records at minimum expense. In such cases it is not the accuracy of the measured quantity, but the comparative quantities, when they occur, how long and why certain loads occur at certain times, that is of paramount importance in interpreting graphic records of this description. Very accurate records are necessary only when a money value is attached to their indications. These records will be of great benefit to those who wish to record the variations in the loads on their equipment and therefore eliminate waste or arrange for more efficient operation.

Thoroughness in Education

EXIGENCIES of the war led to the development of a form of intensive education, the results of which were highly gratifying, and the experience thus obtained has led in some quarters to the assumption that practically all the courses of study in our educational institutions could be much curtailed to great advantage. While benefit might be derived from such procedure in a few instances, it is doubtful whether it would be advisable to adopt such a suggestion at all generally.

In the very nature of things, a course that is laid out with a view toward expedition and expediency rather than comprehensive thoroughness, will impart to the average student only a superficial knowledge which may carry him along very successfully for a short time in subordinate positions, but which would place him at a serious disadvantage when called upon to hold his place among men really trained in their profession. It is to be borne in mind that the man who graduates from a technical or engineering school is really only about to begin an education that must be pursued ceaselessly. And the more thorough his schooling has been the greater advantage can he take of it.

Of those who have had to acquire their technical education outside of working hours, there are probably few that do not realize the tremendous benefit that would have been derived from a good engineering course. Fortunately, there are available today many opportunities in the nature of night schools and correspondence courses, that add greatly to the possibilities of acquiring a satisfying education in many subjects, but in all cases it requires conscientious and persevering effort to accomplish one's purpose.

The man who is painstakingly working his way through such a course should not let himself be discouraged by the fact that the courses, instituted by the Government during the war, educated men in periods of a few weeks or months to a point where they could be entrusted to discharge duties entailing considerable technical ability. A fact often lost sight of is, that many such men were already equipped with a very good schooling, and many who were not thus grounded fell behind.

Such courses were laid out with infinite care to make the most of the short time that could be devoted to them. They were splendidly conceived and excellently administered, to the lasting credit of all the officials and schools concerned. The work they accomplished was little short of miraculous, but the fact remains that it was what might be called empirical education only, and that the man who is desirous of establishing a reputation should not be misled into the error of abandoning earnest study of the fundamental theory underlying the profession he has chosen to follow.

Watch the Ammonia Receiver

ELSEWHERE in this issue John E. Starr, well-known refrigerating engineer, has an article in which he calls attention to the importance of carefully watching the receiver of an ammonia refrigerating plant. As he says in opening, the subject is an old story to operating engineers. But so is draft and thickness of fuel bed in boiler furnace combustion. And like these, the story must be driven home again and again. What we like about Mr. Starr's article is its plain, forceful presentation. The engineer or student who reads it will never forget why he should be careful to feed only liquid through the expansion valve.

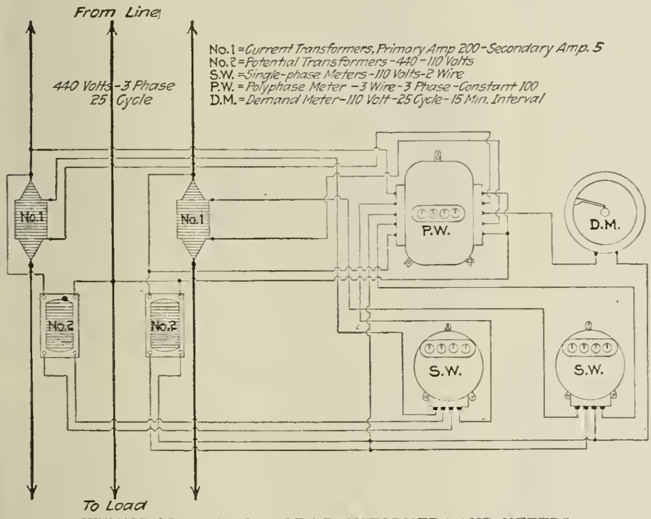
While on this subject we would again emphasize the need of more discussion by engineers of just such aspects of refrigerating-plant operation as is set forth in Mr. Starr's article. As with power plants generally, there must be greater efficiency in the operation and management of refrigerating plants than has been common heretofore. Chiefly by exchange of ideas and practice through the technical press will this end be achieved. What can you add to the progress?

Correspondence

An Interesting Metering Problem

The meter connections shown in the diagram are installed in our plant, for determining the total kilowatt-hours, the average power factor and the maximum demand in horsepower. Can you advise me as to the correct method of determining the following with the meter connections shown?

The average power factor, the maximum demand in horsepower, what would be a fairer wiring; that is, giving if possible higher power factor and lower demand or both? We also take 440-volt current and step it down to 110-volt, through three 10-kw. transformers, delta-connected, for lighting and numerous small heating devices. Would an unbalanced load on the transformers have any effect on the meters, as connected in the diagram, used for determining average horsepower?


From Line
440 Volts-3 Phase
25 Cycle
No.1 = Current Transformers, Primory Amp 200 - Secondary Amp. 5
No.2 = Potential Transformers - 440 - 110 Volts
S.W. = Single-phase Meters - 110 Volts - 2 Wire
P.W. = Polyphase Meter - 3 Wire - 3 Phase - Constant 100
D.M. = Demand Meter - 110 Volt - 25 Cycle - 15 Min. Interval
No.1
No.1
P.W.
D.M.
No.2
No.2
S.W.
S.W.
To Load

WIRING CONNECTIONS OF TRANSFORMERS AND METERS

We are penalized on a power factor of less than 80 per cent. What should be the power factor of the current furnished us? Now suppose our average power factor for one month is 70 per cent. and the power factor of current as furnished us is 85 per cent., what would be our power factor if the incoming current had a power factor of 95 per cent? What is the proper method of determining this?

Quincy, Ill. H. R. Barnes.

[The foregoing letter was sumitted to Victor H. Todd for consideration and the following is the answer given.—Editor.]

In the diagram shown in Mr. Barnes' letter the polyphase watt-hour meter *PW* will indicate the total true kilowatt-hours consumed regardless of unbalancing of the load or the value of the power factor. This same amount will be indicated by the algebraic sum of the two single-phase watt-hour meters *SW*. On power factors between 0.50 and 1.00 one of the single-phase meters will run slower than the other, and the sum of their readings will be the power, or kilowatt-hours consumed. At 0.50 power factor one meter stops and the other records the total power. Between 0.50 and 0 power factor, one reads backward, and its reading must be subtracted from the larger reading to get the total kilowatt-hours; that is, the algebraic sum.

The use of two single-phase meters to determine the power factor on an unbalanced circuit or load is absolutely without value, as the same result may be produced by unbalancing as by low power factor. Therefore, if the lamps and heating devices are connected so that the load is unbalanced, the meters may show high power factor on a low-power-factor load or they may show low-power factor on a high-power-factor load, depending on which phase the single-phase load is taken from and the phase sequence of the three conductors.

On a balanced three-phase circuit the average power-factor is easily determined from the formula,

$$\text{Power factor} = \frac{100}{\sqrt{1 + 3\left(\frac{W_1 - W_2}{W_1 + W_2}\right)^2}}$$

in which W_1 equals the larger single-phase watt-hour meter reading and W_2 equals the smaller single-phase watt-hour meter reading. Most companies use a curve, from which the power factor is easily determined from the ratio of the two readings.

The second paragraph is rather obscure, as there can be only one average, or resultant, power factor in any installation, and this depends on the character of the load, not the supply. In other words, the operating company cannot supply a power factor of 0.85 if the power factor of the load is 0.70. The power factor of the supply line before the load is connected to it has nothing to do with what the power factor of the load will be when connected to the supply. If there are two machines connected to the same meters, one may have a power factor of 0.70 and the other 0.90, while the power factor of the supply and that shown on the meters may be anywhere between 0.70 and 0.90, depending on the ratio of the power consumed by the two machines. The only way to raise the power factor of the load is by changing the character of the load. For instance, an induction motor, which has a lagging power factor, may be replaced by a synchronous motor; then if the rest of the load is lagging, the synchronous motor may be adjusted for a leading power factor so as to neutralize the lagging current and make the power factor of the total load 1.00. Under this condition the meters would indicate 1.00 power factor. This is the condition the operating company desires, and therefore penalizes if otherwise.

As in the case of power factor, the maximum demand is dependent on the load and not the supply; it cannot be lowered by any condition of meter wiring, but can be lowered, if possible, only by changing the time of operation of unit loads so as to obtain a more constant load and not an intermittent peak load. If the dial on the demand meter indicates kilowatts demand, it may be changed to horsepower demand by dividing the kilowatts by 0.746.

The subject of penalizing for low power factor is one of the much discussed present-day problems, as there is no adopted standard definition of "average power factor in an unbalanced three-phase circuit." It is indefinite quantity at present. No power-factor meter will measure it correctly. The nearest approach at present is by using a polyphase wattmeter with three ammeters and three voltmeters in the circuit.

Before changing existing wiring, it would be well to see what the American Institute of Electrical Engineers will adopt as standard in the near future. The writer believes the definition will be somewhat as follows: "The average power factor in a three-phase circuit (balanced or unbalanced) will be the ratio of the real, or true, watts to the apparent watts."

The true watts, of course, are measured by the ordinary polyphase wattmeter. The apparent watts will be the sum of three readings as follows: The product of the current in each line times the voltage measured between that line and an artificial neutral.

In any case, there is no doubt that the A. I. E. E. will adopt definitions and rules for measurement which will clear many misunderstandings and will form the basis for a correct penalty charge for low power factors.

Rainbow Lake, N. Y. VICTOR H. TODD.

Salvaging the Disabled

The spirit of the article published on page 741 of May 13 issue of *Power* is exactly the general attitude and is the one that it is so desirable to change. A point is often overlooked in the fact that there are thousands of partly disabled men (and women for that matter) besides those caused by the war, who must live and often support others. Few of them care to accept charity or alms. Most are able and willing to fit into the industrial system, to become useful members of society instead of a burden upon it and to earn, not ask for, a right to enjoy family life and normal manhood.

The great obstacle is not inability to serve. It is just the attitude expressed in this article; namely, "I don't believe" or "It can't be done." This is the attitude with which an employer tries out the normal man on a job which he claims he can do, but refuses to even listen to the disabled man who wants to prove his ability.

Perhaps a handicapped man could not operate the switchboard under Mr. Peters' charge or a dozen others, but the fourteenth one could. Why should he humble himself, accept alms, be deprived of a normal life, and be a parasite when he can do something useful?

Employers will find that most handicapped men appreciate a suitable job and stick to it better than the average. G. H. BRIDGES.

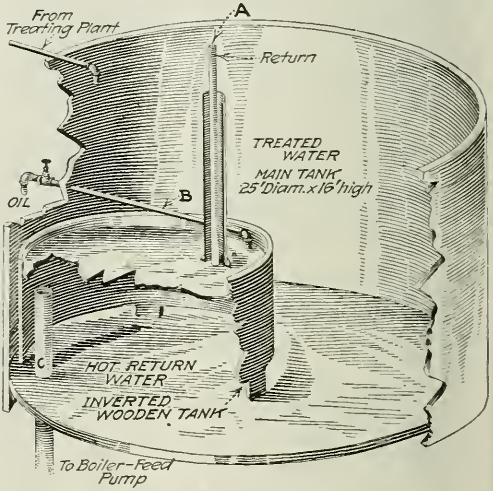
Holyoke, Mass.

Removing Oil from Boiler-Feed Water

The illustration shows the method I worked out to complete the separation of oil from the return water and to retain the heat of the water and return it to the boilers, and also to supply automatically the necessary additional treated water for boiler feed.

After passing through the oil separators the exhaust steam enters the heating coils for heating and drying. The return water is deposited in the inverted tank through the 5-in. pipe *A*, which is incased in a 10-in. pipe, the space between the pipes being filled with 85 per cent. magnesia.

The level of the treated water in the main 25-ft. diameter, 16-ft. high tank is always maintained at or above the top of the inverted tank. The oil remaining in the return water is separated by gravity and can be drawn off from where it collects at the high point at top of the inverted tank, which is set higher at one side than at the other, through pipe *B*. The feed water is taken through the inlet of the pipe *C*, which is 15 in. from the top of the inverted tank, to the boiler-feed pump and thence through a closed heater to the boilers.



DESIGN OF RETURN-WATER TANK AND PIPING

The hot return water does not mix with the treated water, but like the oil, stays at the top of the inverted tank. The inverted tank is of 2-in. wood and is a fairly good insulator. The deficiency in return water for feeding the boilers is automatically made up by the treated water flowing under the edge of the inverted tank and rising to the outlet of *C* as required. The mixture of return and makeup water is delivered to the pump at from 140 to 150 deg. F.

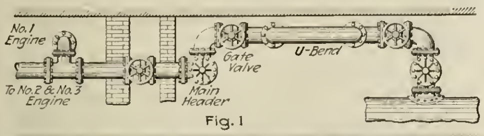
Originally, the main tank was used for the treated water, the return water from certain branches giving no trouble from oil. The other return water was put through the treating system to remove the oil. We found it very difficult to properly treat the mixture of return and raw water, and practically all the heat was dissipated before it reached the boiler-feed pump.

The system described has been in use over a year, and during that time there has been no indication of oil in the boilers. H. A. WARD.

Cincinnati, Ohio.

Improving a Defective Piping System

On account of scanty headroom above three water-tube boilers and three vertical high-speed compound engines that supply power for an office building, the connecting system of high-pressure steam piping could not be laid out exactly in accordance with correct engineering principles. Figs. 1 and 2 show how the piping was originally planned. The three boilers were connected through 10-in. leads containing expansion loops, to a 14-in. header running along the partition wall between the boiler and the engine rooms. The 10-in. main supply pipe for the three engines was connected to a side opening in the main header, instead of to a top opening as it should have been to secure the best results and as it would have been had not the restriction already mentioned interposed. Steam separators were inserted in the branch pipes running from the main supply pipe to each engine.



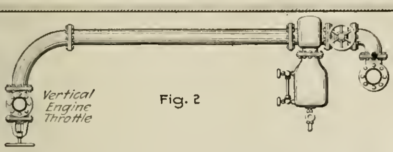


FIG. 1. MAIN PIPING AS ORIGINALLY ERECTED
FIG. 2. BRANCH TO ENGINE IN ORIGINAL LAYOUT

When the plant was started, it was found that the steam entrained an enormous quantity of water. The boilers had to be run with the water barely showing in the gage-glasses to keep slugs of water from getting by the separators in the branch pipes and wrecking the engines. The priming seemed to be more than ordinarily excessive whenever an engine was being speeded up preliminary to cutting it into service. It usually required about twenty minutes or more to accomplish this.

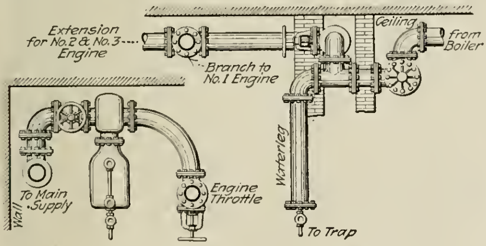


FIG. 3. BRANCH TO ENGINE IN ALTERED SYSTEM

FIG. 4. MAIN PIPING REMODELED

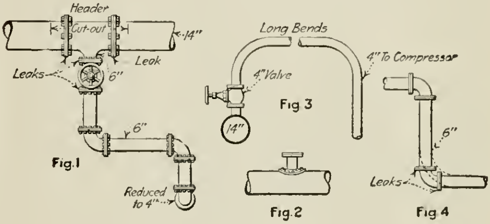
How the difficulty was finally overcome will be understood from Figs. 3 and 4. In the original construction the main supply pipe for the engines ran directly above the three dynamos to which the engines are directly connected. To obviate any possible trouble from leaky joints or otherwise, on this account, it was determined to shift the pipe to the direction opposite from the engine. This was done by branching along the partition wall at right angles to the original course of the piping. To intercept the slugs of water coming through from the main header, it was also determined to insert an amply proportioned separator at the branching point. But the need of running the pipe between the wall and an adjacent supporting column so reduced the available space as to make it impracticable to connect up a regularly designed separator, so that it became necessary to improvise one. Fig. 4 shows how this was done. Fig. 3 shows how the supply branch to each engine appears in the altered system.

The new arrangement works very well. The waterleg, with its connections, makes an effective separator, working on the principle of momentum. Any bulky rushes of water that get into the header are carried by their momentum out of the path of the steam current and into the drop leg, whence they are trapped back to the boilers, while the separators in the branch pipes take care of the lighter entrainment.

St. Louis, Mo. A. J. DIXON.

Leaking Flange Joints

I see in reading the Mar. 4 issue of *Power*, page 325, that F. C. Heylman does not agree with the arguments of many engineers that so many flange connections are the cause of leaks, especially as there are so many good gaskets on the market.



FIGS. 1 TO 4. SHOWING PIPE CHANGES

There can be too many flange connections in any power-plant piping system, and they will cause leaks and will give no end of trouble. I have proof of it in the plant where I am employed. The 14-in. header extends through the engine room, and two large air compressors are piped to it, also a Corliss engine. The original header connection to one compressor is shown in Fig. 1.

In this piping there are ten flange joints and all of the best known gaskets were tried, but none held tight for long. The master mechanic had about 36 in. cut out of the header and then had a piece welded in, as shown in Fig. 2, with a 4-in. saddle connection riveted on this 14-in. piece. Then the job looked as shown in Fig. 3 and the leak was gone.

Another pipe, about 200 ft. long, caused some trouble by leaking at the flanges where it turned through the wall and to the other engine room. The original is shown in Fig. 4. A piece of the 6-in. pipe was cut out on each side of the ell and a long bend welded in place, as shown by the dotted lines. It might be said that there was an expansion joint in this steam line, but it did not prevent leakage at the ell. Since the welded bend was put in there are no joints to leak.

Columbus, Ohio. L. A. COLE.

Short Courses for Engineering Graduates

Regarding the article entitled "Short Courses for Engineering Graduates," by Prof. J. O. Kammerman, on page 731 of the May 13 issue of *Power*, I would like to ask why a prolonged period of training is necessary for young engineering graduates. I know some of the so-called war engineers who have been rushed into responsible positions during the war and have made good, and they are making good today, and some of them will hold their positions.

These young fellows have not been through the cable-dragging course in manufacturing plants, nor chipped iron warts from castings, when their importance was personally most felt, but they delivered the goods during the war and can do so in peace time.

It is discouraging for a graduate engineer to face several years of training, mostly physical, in a manufacturing plant at nineteen cents per hour for the first year and a two-cent increase for the second year and, after having served his two years, to almost know he will have to start out with, maybe, a white-collar job paying $50 a month, on account of lack of experience. Most of the want ads call for at least five years' practical experience in order to get enough salary to eat.

If a young engineering graduate has initiative and some self-confidence, he can make good if the opportunity presents itself. As an illustration, I, together with fifteen engineering graduates from recognized universities and colleges, entered the apprentice course of one of the largest manufacturing plants in the country. This course was the usual one, mostly physical labor, and it was optional with the apprentice as to his learning as he passed from one department to another. Ten of these fellows remained five months and left the plant, three went into the sales department at the end of eight months and two served the two-years' course. In addition to serving two and one-half years, I put in a thousand hours overtime so that I might smoke a really good cigar now and then.

These fellows could not see their way clear to drag cable and wait on workmen month after month without any hope of seeing the test floor inside of a year. One of the men who served eight months took the bull by the horns and today is manager of a district office for a large concern, and it took him only three years to get the job and a good salary. Others did as well.

If a fellow has initiative and self-confidence, I repeat, he can cut out a large part of this prolonged training. As to the older and experienced engineers helping the young engineer along, it cannot be denied that experience is not always the best teacher. Older men can help the young ones over a lot of rough places if they will just take the interest and time to do it.

From personal experience I know that the young man will not always ask questions that he wants to ask lest he expose what he thinks is his ignorance. In one sense it is not his ignorance, but his lack of experience, and the older man could put the young fellow straight in a few minutes, while, on the other hand, it may be a long time before the young fellow gets a chance to put himself straight.

Let the older engineer pay more attention to the seemingly insignificant details brought up by the youngsters and thereby shorten the training period. I make it a point to tell my young associates that asking about what is uncertain or confusing is the easiest and quickest way of getting straight on the subject. I also take time to explain points to the electrician or wireman who shows an inclination to learn. No one knows it all, and asking questions is no sign of ignorance.

Let the older engineer pay attention to the learning wants of the young engineer, and there will not be so many degree men who do not know where to put the equalizer between two compound generators or how to read a potentiometer. A. W. KOINER.

Norfolk, Va.

Experiences With High-Head Turbines

The account of the failure of a water-turbine case, in a recent issue of *Power*, recalls some experiences I have had with high-head turbines of similar design. In a practically new plant operating under a 175-ft. head the racks at the forebay lacked about 3 in. of being wide enough. A limb 2½ in. in diameter and 14 in. long came through this opening and into the turbine case. When a large motor went short and the governor opened the wicket gates wide, one end of the limb stuck in between the gates. The short threw the circuit-breaker, and as the governor could not shut the gates, the machine began running away. The hand-operated 24-in. valve that let the water into the case was between the wheel and the generator. When the voltage reached 2,600 I threw the exciter switch and started for the valve; but by the time I reached it the speed of the machine had expanded the field poles so much that they were rubbing the armature. Smoke and fire flew, but I finally succeeded in shutting the water off. The field poles had to be taken out and some of them had to be rewound. The armature was not damaged to any great extent.

A short time after that, with a heavy load on the unit, one of the poles broke loose from the spider. The poles were bolted on with 1¼-in. bolts, two in each pole. The machine made about three-quarters of a revolution and stopped. Of course the Lombard governor opened the gates wide; this was a Type R governor with a pressure and exhaust tank, the pump being belted to the waterwheel shaft. With the wheel stopped, the pump could not return the oil from exhaust to pressure tank. The operator tried to shut the gates with the small hand lever and regulating valve, but could not do this as there was as much pressure in front of the piston as back of it. Instead of opening the air valve and letting off the pressure from the exhaust tank, he threw out the clutch that releases the gates for hand control. The gates snapped shut, causing such a surge that, although there were two 18-in. surge pipes on the penstock, it made a 14-in. crack in the flange, where the pipe to the wheel was riveted to the penstock. The bolts in nine of the twelve field poles were found to be sheared off, and all we ever found of the pole that broke first was some of the wire coil. The rest was ground into the armature. This generator was built as an experiment anyhow, and, concluding we had experimented enough with it, we broke it up and installed an up-to-date generator in its place.

With a Lombard governor we always shut the wicket gates in the wheel case before releasing the clutch, as only a small gate opening will cause a violent surge if the gates are allowed to snap shut when operating under a high head. V. C. WOOD.

Copenhagen, N. Y.

Inquiries of General Interest

Increasing Ammonia-Compressor Speed—If an ammonia compressor is speeded up and the expansion valve is not opened more than before and no more water is turned on, over or through the condenser, what will happen?

B. H. C.

Because of the increased compressor speed, the cooling coils (that is, expansion coils) will soon be emptied of liquid, the pressure therein will be reduced, while the condenser pressure will increase. There will be a slight drop in temperature in the room cooled, owing to the suddenly increased evaporation of liquid in the coils, but as the expansion valve opening is not increased to admit more liquid, the room temperature will soon go up. There is likely to be trouble with the compressor stuffing-box packing.

Capacity of Wooden Tank—What quantity of water would be contained by a wooden tank having inside measurements of 18 ft. diameter at bottom, 17 ft. diameter at the top and 14 ft. deep?

J. B. A.

The volume is given by the prismoidal formula; namely *Volume = 1/6 depth × (area of top + area of the bottom + 4 times the cross sectional area at mid-depth)*. The area of 17 ft. diameter = 17 × 17 × 0.7854 = 226.98 sq.ft.; the area of 18 ft. diameter = 18 × 18 × 0.7854 = 254.47 sq.ft., and as the diameter at mid-depth would be (18 + 17) ÷ 2 = 17.5 ft., the area at mid-depth would be 17.5 × 17.5 × 0.7854 = 240.53 sq.ft., and by substitution the formula becomes

Volume = $\frac{14}{6}$ [226.98 + 254.47 + (4 × 240.53)] = 3368.33 cu.ft., or 3368.33 × 7.48 = 25,195 gal.

Operation of Turbine Governor—With a hydraulic turbine governor, will the governor remain in the same position as long as speed of the turbine is the same, or do the governor weights stand at different positions for different loads on the turbine?

W. G. B.

When a turbine is governed by the indirect, or what is commonly called the "relay" method, the centrifugal force of the governor is needed only to "give the signal," which sets in motion an auxiliary mechanism by which the valves are moved by gearing connected to the main shaft or by steam or by hydraulic pressure. The signal is given for more or for less speed, according to requirements and continues until the correct speed is satisfied. There is the same speed and therefore the same standing of the governor weights when the speed is satisfied with one load as with another, within the range of variation required for operation of the pilot valve.

Stream Flow Required for Hydro-Electric Plant—What would need to be the rate of flow of a stream with 16 ft. working head for development of sufficient power with turbine waterwheels for driving one 100- and one 75-kw. generator?

S. K. W.

The efficiency of the generators would be about 90 per cent. and the net efficiency of turbines and power transmission would be about 70 per cent., making an over-all efficiency of about 63 per cent., and as 1 kw. is equal to development of 44,240 ft.-lb. per min., then for each kilowatt actually generated, the water would need to develop 44,240 ÷ 0.63 = 70,222 ft.-lb. per min. With 16 ft. head each cubic foot of water used per minute would develop 16 × 62.3 = 996.8 ft.-lb., so that each kilowatt output of the generators would require a flow of water at the rate of 70,222 ÷ 996.8 = 70.45 cu.ft. per min., generation of 100 kw. would require 7045 cu.ft. per min., and 75 kw. would require 5283.75 cu.ft. per min.; or for driving both generators at the same time, the flow needs to be at the rate of 12,328.75 cu.ft. of water per minute.

Striking Atmospheric Pressure Line of Diagram—Should the atmospheric pressure line of an indicator diagram always be drawn on the card and be made before unhooking the cord from the reducing motion, and is it not equally well to strike the line afterward while drawing out the cord by hand?

T. A. A.

The atmosphere line is the base line of the diagram, and while not necessary to be taken into account in measuring the diagram, excepting as a convenience, it is necessary for complete interpretation of the diagrams. In all cases the atmosphere line should be struck on the card immediately after diagrams are taken so it will be located as nearly as possible under the same conditions as those under which the diagrams were made. Subsequent drawing of the atmosphere line is likely to give it a false position, and when the cord is drawn out by hand it becomes necessary to "square up" the card to determine the length of a diagram.

Size of Conductors—What size of conductors will be required to transmit 1600 hp., at 0.75 power factor, 15 miles with a loss of 7 per cent. of the power generated in the line; the circuit to be three-phase with 11,000 volts at the generator, conductors spaced 36 in. apart? Also, what will be the per cent. regulation?

R. M. S.

With 11,000 volts at the generator the voltage to neutral of a three-phase circuit will be 11,000 ÷ 1.732 = 6350. Assuming 15 per cent. regulation, the volts E to neutral at the receiver end of the line will be 6350 ÷ 1.15 = 5520. The watts W = hp. × 746 = 1600 × 7.46 = 1,193,600, and the current, I, per wire, when the power factor is 0.75, is $I = W \div 3E \times P.F.$ = 1,193,600 ÷ (3 × 5520 × 0.75) = 96 amperes. Allowing the loss in the line to be 7 per cent. of the power generated, the watts loss per wire is $W_n = \frac{W}{3} \times \frac{0.07}{0.93} = \frac{1{,}193{,}600}{3} \times \frac{0.07}{0.93} = 29{,}947$. Resistance per wire = $W_n \div I^2$ = 29,947 ÷ 96 × 96 = 3.25 ohms; and the resistance per mile is 3.25 ÷ 15 = 0.217 ohm. The nearest size standard wire is a 250,000-circ.mil conductor, which has a resistance of 0.2253 ohm, making the total resistance of one wire equal 0.2253 × 15 = 3.38 ohms. With conductors spaced 36 in. apart, the inductive reactance in ohms, at 60 cycles, per mile of single 250,000-circ.mil conductor is 0.626, making a total of 0.626 × 15 = 9.39 ohms.

Knowing the receiver voltage E, the generator voltage E_g is found by the formula,

$$E_g = \sqrt{(E \cos \theta + IR)^2 + (E \sin \theta + IX)^2}$$

where R is the resistance ohms and X the reactive ohms of one conductor, and θ the angle corresponding to the power factor in the circuit. For a power factor of 75 per cent. $\cos \theta = 0.75$ and $\sin \theta = 0.66$. Then

$$E_g = \sqrt{(5520 \times 0.75 + 96 \times 3.38)^2 + (5520 \times 0.66 + 96 \times 9.39)^2} = 6370 \text{ volts}$$

$$\textit{Per cent. regulation} = \frac{E_g - E}{E} \times 100 = \frac{6350 - 5520}{5520} \times 100 = 15 \textit{ per cent.}$$

This value is close enough for all practical purposes. It should be noted that there is no direct method of making these calculations. A certain per cent. regulation is assumed and the calculations made. If this does not come close enough, another value is assumed and the calculation made again until the correct value is obtained.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. —Editor.]

Saving Fuel in Industrial Heating Systems[*]

A source of easily preventable loss incurred by many factories is that of the use of live steam for heating and for other purposes where exhaust steam would be at least as satisfactory. The manner in which the exhaust-steam problem is handled constitutes the greatest single determining factor in the economy of a steam plant.

LARGE economies are frequently possible in heating a factory. There are many steam-heating systems that consume from two to three times the volume of steam required, as, for instance, by using steam for heating directly from the boiler while wasting enough exhaust steam to supply all heating demands. Assuming a heating system taking steam at the rate of 3000 lb. per hour directly from a boiler, under a pressure of 125 lb. gage, we can, by installing an engine operating at a 30-lb. water rate, develop 100 i.hp. and still leave in the steam about 92 per cent. of its original heat. By supplying directly from the boiler the slight additional amount of steam needed for heating, we gain 100 hp. at the cost of a very slightly increased fuel consumption.

It often happens that a smaller total quantity of steam is used by a properly proportioned engine and heating system operated together than when the engine is not running and the heating demand is supplied by live steam direct from the boilers. The smaller steam consumption with the engine is due partly to the fact that the heating system, designed for the lower temperature, has too large a radiating surface for the hotter live steam, and there is waste through overheating. The reëvaporation loss later discussed is also greater with higher-pressure steam.

OWNERS ARE PRONE TO UNDERVALUE THE HEAT CONTENT OF EXHAUST STEAM

Managers and owners have a decided tendency to undervalue the heat content of exhaust steam. Taking the average type of noncondensing factory engine, it is safe to state that over 90 per cent. of the heat supplied at the throttle is available for heating purposes in the exhaust steam. The less efficient the engine, pump or turbine, the greater the percentage of heat contained in its exhaust.

Poorly designed heating systems are responsible for the needless use of live steam to correct faulty circulation, but it is always possible to substitute exhaust for live steam, where poor circulation is the cause of the trouble, by suitably modifying the piping system.

Transfer of heat from the steam to the air or any other substance can occur only when the substance is at a temperature lower than that of the steam, and the rapidity of heat transfer increases as the temperature difference between the two bodies increases. Where the pressure and, therefore, the temperature of the steam is low, a larger amount of radiating surface is required than for the transmission of the same amount of heat by means of high-pressure steam. But it will often be found that low-pressure exhaust steam can be substituted for high-pressure live steam without increasing the amount of radiating surface, provided the original system is susceptible of improvement in the matter of circulation. In a case of this kind exhaust steam at one-half lb. gage pressure substituted for live steam at 20 lb. gage actually increased the heating effect. Bad circulation may be caused by inefficient draining of condensation, steam piping of restricted area and complicated lines, air binding of radiators, etc.

The chief requirements for a good low-pressure heating system are: (1) Removal of oil from exhaust steam; (2) free circulation of steam with least possible pressure drop from the engine to the radiators; (3) continuous and effective removal of air and condensation from coils and radiators; (4) prevention of escape of steam from radiators; (5) the return of all condensation to the feed-water heater. Such a heating system is later described in fuller detail.

Great waste of steam occurs through inefficient steam traps for discharging from radiator units the condensation and air and for preventing the escape of uncondensed steam. Owing to insufficient care and supervision and badly designed traps large quantities of steam are discharged into the drip lines, with a consequent waste of fuel sometimes amounting to 200 per cent. of the amount required under efficient conditions. Oftentimes radiators are found without traps, and hand regulation of the drip valve is depended upon, usually resulting in much waste.

WASTE CAUSED BY USING HIGH-PRESSURE STEAM IN HEATING COILS

When high-pressure steam is used in heating coils, an additional waste ordinarily results from a reëvaporation of a part of the condensed water in the coil upon its discharge through the trap into a lower pressure. This water is practically of the same temperature as the high-pressure steam in the coil, so that when it passes into the lower pressure of the return line a portion of it, depending in amount upon the difference in temperature between the two lines, evaporates into steam which is of no service for heating. It is possible, however, by a special piping and trap arrangement to conserve this reëvaporation for use in the low-pressure portion of the heating system of the plant.

Where exhaust steam is substituted for live steam the saving will be approximately eight times that of returning an equal weight of hot drips. A false impression exists that much less fuel is required to generate steam at low pressure than at high pressure, but as steam at 151 lb. gage has only about 4 per cent. more heat than steam at 1 lb. gage pressure, the fuel required in the two cases varies but slightly.

The rate of transfer from radiators depends partly on their form; the rate increases with increasing difference of temperature between steam and air and also with the velocity of air passing over the radiating surface. In still air this rate is nearly 1.8 B.t.u. per hour with a temperature difference of 142 deg., but several times this value when the air is forced at high velocity over the radiating surface, as in the blast coil heaters of indirect systems. Therefore, this type of heating apparatus requires only a fraction of the radiating surface required in a direct heating system. In water heating by means of steam coils a more rapid transfer of heat obtains. In an ordinary closed type of feed-water heater this amounts to about 180 B.t.u. per sq. ft. per hour per degree temperature difference.

DIRECT AND INDIRECT HEATING SYSTEMS COMPARED

The *direct* system comprises a number of radiators of steam coils located in such a way as to give the desired distribution of heat. Mains and branch lines of piping connect these radiating units to the source of steam supply, and another piping system serves to collect the hot condensation and return it to the feed-water heater of boilers. The regulation of heat is governed by numerous valves attached one to each of the units throughout the plant. These valves are regulated usually by hand, but may be designed for automatic control by means of a thermostatic device. A well-designed direct system is economical of steam and for many sets of factory conditions is more satisfactory.

The *indirect* or blast coil system comprises a fan arranged either to force or induce a current of air through a bank of tubes containing steam and set in a housing from which the heated air is distributed in pipes or flues to the desired locations. Return flues may be specified whereby the warm air after its first use is returned to the fan inlet for reheating and continued circulation.

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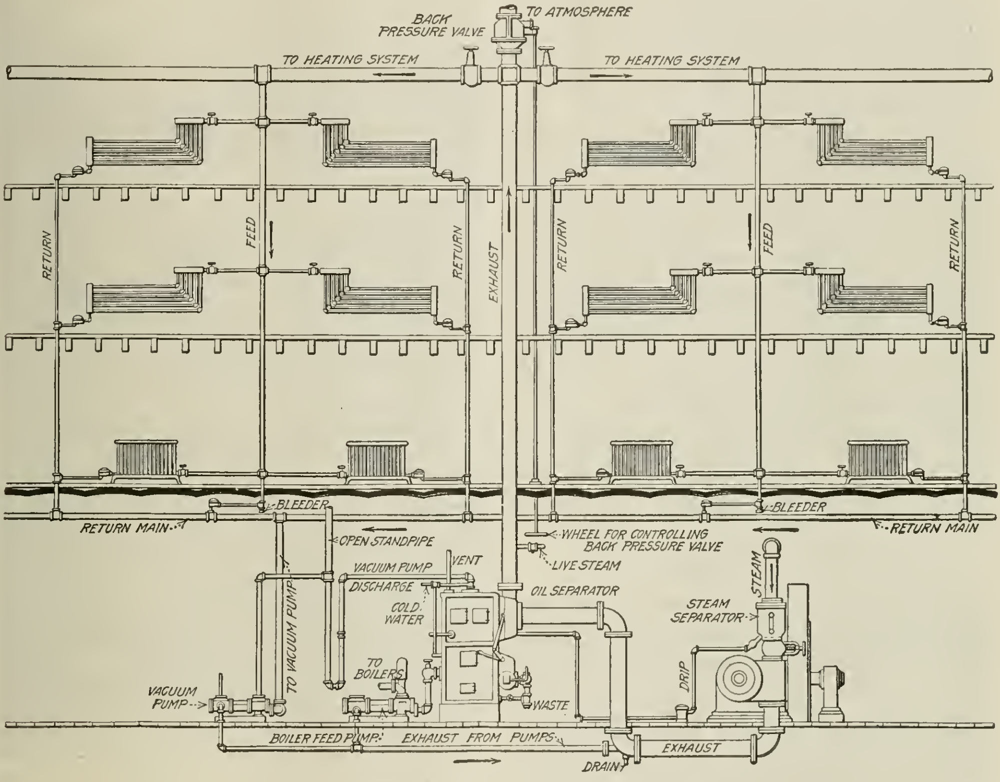
[*] Abstract of Engineering Bulletin No. 6, prepared by the United States Fuel Administration in collaboration with the Bureau of Mines.

The *indirect* system provides a positive method of ventilation of the buildings and rooms. A specified number of air changes per hour can be effected both summer and winter, and in the warm months the air may be cooled by a water-spray arrangement, thus producing more efficient working conditions for the employees. An engine or motor is required to drive the fan, and the volume of air, the degree of heating or conditioning are under centralized control in the power plant. The amount of radiating surface is much smaller than with the direct system, and drip piping is short and does not extend out of the power-plant department. There are no radiators at distant points, the valves of which might require the attention of the engineering staff. The cost of installation may be either more or less than the direct system, depending upon requirements. The steam consumption of the blast system is greater usually than that of the direct system, owing to the fact that generally more air is heated with a greater number of air changes per hour. Furthermore, a great waste occurs in constantly heating a fresh supply of cold air unless a very efficient return duct system is planned and intelligently used. A direct-connected steam engine forms an excellent drive for the fan, owing to ease of speed regulation, although a variable-speed motor may often be employed. The exhaust from the fan engine is generally piped into the blast-heating coils, where it may be efficiently utilized in cold weather, providing there is not already a surplus of exhaust in the plant.



EFFICIENT LOW-PRESSURE SYSTEM FOR FACTORY HEATING

The handling of the heat problem in conjunction with the power plant of a factory has a greater influence on the over-all economy than any other feature of the design and operation. Where a steam plant is used the following rules must be strictly adhered to:

1. Never, if you can avoid it, produce more exhaust steam than can be used at all times of the year, day and night.

2. If noncondensing units cannot be utilized for the power requirements which will at the same time conform to rule 1, then operate noncondensing units only for such time, periods, and loads as will just balance the heating demand, and have a unit or units of the most economical type to carry the balance of the purely power load. The same effect may sometimes be obtained by use of a bleeder type of steam turbine. Sometimes the most economical units for power only may be oil or gas engines.

3. Never use live steam for a purpose to which exhaust steam can be applied.

4. If a plant contains noncondensing units only, maximum efficiency is obtained when the production of exhaust is equal to or less than the heating demand, but never when an excess of exhaust is produced. When less exhaust is made than the quantity wanted, it is proper to draw live steam from the boilers to supply the deficiency.

In laying out the heating design for any industrial plant the first consideration should be the heating of the boiler-feed water with exhaust steam. Then the balance of the exhaust should be applied to the remaining uses. If the water for boiler feed has an initial temperature of 60 deg., about one-seventh of the total boiler output after passing through and performing work in simple engines will be condensed in heating the feed water to a temperature of 212 deg. In a condensing plant the exhaust from the auxiliaries, if properly specified, can be made to balance this requirement. Where no other heating is wanted, the danger is always that of producing too much rather than too little exhaust for the needs.

An important requirement in connection with the heating system is the separation of oil from the hot water returned to the feed-water heater and boiler. Failure in this regard will probably result in burning, bagging or blistering the boiler tubes or shells. Two methods of elimination are possible, and it is generally advisable to employ both.

TWO METHODS OF SEPARATING OIL FROM RETURN FEED

1. Extract the oil from the steam by use of oil separators inserted in the exhaust piping. Separators should never be specified by the size of the exhaust pipe, but by the quantity in pounds of steam per hour to be cleansed of oil.
2. The second way to remove oil from the feed water is by filtration. Several makes of good oil filters or grease extractors are on the market, which may be inserted in the feed line between the pump and the boiler. Some open-type feed-water heaters include a filter as part of the apparatus and this may assist materially in the elimination of oil from the water.

It is apart from the present purpose to treat in detail the various types of steam-heating systems, but since one type in particular has proved highly efficient for factory low-pressure heating work, a description of its operation will be of value. It will be noted that it provides for those features which have been specified as essential to efficiency. The plan is known as the vacuum return lines system. It is shown complete in all its essential parts in the illustration. Its object is to insure a positive circulation of the steam to all portions of the radiators, to near and distant units alike; to obviate the necessity of carrying heavy back pressures on the engines, to produce this circulation, thus effecting pronounced gains in efficiency and capacity of the prime movers; to remove automatically from radiators all condensation and air as they accumulate and to prevent waste of uncondensed steam.

In addition to these features it is common practice to so arrange a regulating valve that when the pressure in the heating main falls below a predetermined standard, indicating a deficiency of steam for heating, this regulating valve will open sufficiently to make up the shortage by admission of live steam direct from the boilers.

AN EFFICIENT LOW-PRESSURE SYSTEM FOR FACTORY HEATING

Referring to the illustration, the exhaust from the engine leads directly into the feed-water heater giving the first preference of the steam to the heating of the feed water. Combined with the feed-water heater there is an oil separator which is to cleanse the steam before its contact with the feed water or its entrance into the heating system. The remainder of the steam, not condensed by heating the feed water, flows upward to a back-pressure valve which is set to maintain the pressure required for the operation of the heating system, and to discharge to the atmosphere any steam excess. In ordinary practice, the back pressure may be as little as zero to 1 lb. gage at the engine, though with very long exhaust mains it may be necessary to carry slightly heavier back pressures. At a point between the feed-water heater and the back-pressure valve, branch mains carry the steam supply for its distribution to the various units of radiation. Each radiator or coil is equipped with a hand or automatically regulated inlet valve and has a vacuum return-line valve at its lowest point which connects with the return-drip system leading back to the vacuum pumps. The function of the vacuum return-line valves, which operate on different principles according to their make, is to permit the removal of condensation and air and to prevent the escape of steam from the radiators.

Vacuum systems are often found working in a very inefficient manner, even after they have been correctly laid out and installed. The usual cause is the discharge through traps which connect the return line with high-pressure radiation. The action of reëvaporation occurs and fills the return main with steam. Then in order to regain and maintain the vacuum, a cold-water jet near the intake of the vacuum pump is inserted to "kill" the steam. This is a bad practice for which there is no excuse. No high-pressure radiation should under any circumstances be directly connected to a vacuum-return line.

The vacuum pump discharges and returns into the feed-water heater, into which is connected a cold-water makeup supply, automatically governed to supply any deficiency in the feed. The feed pump receives this mixture of heated makeup water and reheated condensation. The vacuum pump maintains a pressure in the return lines of considerably less than atmospheric. (An 8- to 10-in. vacuum is the common practice.) Consequently, if only atmospheric pressure exists inside of the radiators, there is a difference of pressure between the inlet and outlet of each vacuum return valve which acts to discharge the air and condensation from the radiator. Between the vacuum pump and the feed-water heater is a vented tank or standpipe, which serves to free the air from the hot returns before entering the heater.

Each radiator acts as a condenser for the steam supplied to it and causes a reduction of pressure within itself as long as the air and water are continuously removed. This reduces the pressure in the radiators, which may be atmospheric or slightly less, causes a free inflow of steam through their regulating valves and reduces to a minimum the pressure required in the supply main to cause the necessary circulation of the steam. The result is a minimum back pressure on the engine with the attendant economy in its operation. The proper application of the vacuum return-line system may frequently reduce the back pressure sufficiently to increase the capacity of the engine 10 to 20 per cent. with a consequent saving of steam. But the greatest saving is likely to be in cases where its use permits the substitution of exhaust for direct steam.

Hot-Water Heating Boiler Explodes at Camp Mills

The explosion of a sectional cast-iron hot-water heating boiler at the sanitary camp at Camp Mills, Long Island, New York, June 30, was responsible for the death of two men, civilian employees. The accident was caused by the failure of the last section of a six section boiler, used for heating water for shower baths, etc.

An investigation is being made by the officials of the camp, and, although this has not been completed, it has gone so far that they are satisfied that the boiler as regards metal or construction was not at fault.

This boiler was installed since the camp was built, owing to the original boiler capacity being insufficient to supply the needs that is put upon the system, and it is possible that an attendant failed to open a valve, or that the relief valve did not operate, and thus allowed a pressure to build up when the fire was started in the furnace.

Foreign Traders Need Federal Incorporation

A bill to permit the Federal incorporation of companies engaged in foreign trade has been introduced in Congress.

This project is approved by the Government, the American Chamber of Commerce in China, the National Foreign Trade Council and others interested in foreign trade. It aims to remedy the situation now existing in many foreign countries. The need for it is especially great in China, where at present a company formed by Americans and backed by American capital can be incorporated only under the laws of Great Britain or else those of one of the different states. These state laws are so unlike and change so constantly, and court procedure and decisions vary so much in the different states, that the laws are generally distrusted abroad, and it is difficult, often impossible, to secure investment of foreign capital in American concerns organized under these laws.

Samuel T. Wellman

Samuel Thomas Wellman, past president of the American Society of Mechanical Engineers, died suddenly of heart disease, July 11, at Stratton, Me., while on his way to the camp of the Megantic Fish and Game Corporation, of which he was a member.

He was born in Wareham, Mass., in 1837, was educated in the public schools of Nashua, N. H., and attended Norwich University. He was a veteran of the Civil War, having served with the First New Hampshire Heavy Artillery in 1864-5. At the close of the war he resumed his engineering practice. He built the first Siemens gas regenerative heating furnace in the United States, and also the first openhearth furnace for making steel on a commercial scale. Mr. Wellman became consulting engineer for the Illinois Steel Co. in 1889, and the following year became interested in a company which bought the works of the Chester Rolling Mills Co., Chester, Penn., becoming its president. Soon after, with his brother, he organized the Wellman-Seaver Engineering Co.

SAMUEL T. WELLMAN

Mr. Wellman was an inventor as well as a promoter, the best known of his patents being the Wellman hydraulic crane and the Wellman openhearth charging machine. In his later years he was identified with the steel industry of the Great Lakes. He was a director and the largest stockholder in the Solid Steel Co., of Alliance, Ohio, and a director and stockholder in the American Wire Co., of Cleveland.

The North American Light and Power Co., one of the largest utility companies in southern Illinois, has purchased the Southern Illinois Light and Power Co., and took charge about June 15. The North American Co., with this newly acquired property will be the largest utility company in the state of Illinois. It will furnish light and power for nearly 200 towns.

International Power Economy Conference

The International Power Economy Conference was organized in Chicago, Ill., Dec. 6, 1918. The object of the conference was to bring together manufacturers of power-plant apparatus with a view of securing aggressive and concerted action by which the United States Fuel Administration might be perpetuated. The conference went on record as indorsing the work of the United States Fuel Administration, and recommended that steps be taken to form a permanent organization.

Subsequently, various committees have been appointed and the work of organization has now reached a point where a program can, with some degree of certainty of fulfillment, be arranged for a conference which will be called at Chicago in October of this year.

The committee to coöperate with the Fuel Administration has been in correspondence with eminent fuel engineers and experts in power-plant efficiency and has submitted as a basis for the present work the proposed plans prepared by David Moffat Myers, until recently advisory engineer of the United States Fuel Administration. An abstract of Mr. Myers' plan follows:

In formulating the campaign of the United States Fuel Administration for conserving fuel along the lines of maximum production of industry with minimum waste of fuel, the consideration of permanence was carefully considered and planned for. Let it be stated clearly that the kind of conservation which will be hereinafter discussed is true conservation, not limitation of industries. In proof of the practicability of true conservation the national plan having the slogan "Maximum Production with Minimum Waste" resulted in a saving of 12,500,000 tons of coal in six months in the power plants of the industries and on the railroads. This is the kind of conservation which deserves permanent life, and it should become a most valuable feature of future government service to the people.

The public at the expense of laborious work and the best economic thought has been taught the idea of conservation and elimination of unnecessary waste. If the effort is now relaxed, the momentum of the movement will never again be regained. Therefore, now is the time to act and the action must be immediate.

Since a permanent service is required, it is natural to look to a permanent branch of the Government. A review of the departments immediately fastens our attention upon the Department of the Interior. The Bureau of Mines is the most authoritative source of information in the country on fuels and their conservation, and the Geological Survey has made careful study and survey of the possibilities of water throughout the country and also the possibilities of extending the use of water power. These two branches of service are coördinated under the Secretary of the Interior and are the logical means for handling this national problem from headquarters in Washington.

It is essential in the proposed plan that an engineer be appointed by the Department of the Interior to hold office in each state, and report to the Department of the Interior in order to keep the Central Bureau of Conservation thoroughly informed on local conditions and problems throughout the whole country, and that all members and officers for the new work be appointed by the Bureau of Mines and that all such appointments be kept clear of local and, as far as possible, of Federal political influence.

The first phase of the subject which should be undertaken is the continuance of the educational and publicity propaganda started by the Bureau of Mines and continued and intensified by the United States Fuel Administration, which would hand over all of its information and facilities as fast as possible.

Among other elements to be desired is an advisory committee including first of all an engineering element made up of members of the four National Engineering Societies, members of the National Labor Organizations, members of the Federal Chamber of Commerce and others to be suggested.

A function of the undertaking should be that of interesting itself in the correct design of new power plants and in supervising changes of power equipment in existing power plants, which do not at the present time always lead to better economy, but should in the future be made to do so. We should also look forward to the future recovery and utilization of the valuable byproducts of coal resulting from low-temperature distillation.

In addition to the 25,000,000 tons of coal annually saved in the industries and railroads alone, other savings have been effected within this same policy of maximum production with minimum fuel waste. Some of these are included in the following table:

	Tons
Railroads	7,000,000
Steam plants	18,000,000
Skip-stop	700,000
Isolated plants	272,000
Water power	196,000
Domestic	400,000
Duplication	48,000
True conservation results	26,616,000

This saving of nearly 27,000,000 tons per year represents the result of only six months of effort on the conservation plan, during which period the connected organization was in process of formation and even now only covers 25 of the 48 states. With complete and permanent organization such as proposed, an annual saving of 50,000,000 tons of coal would be a very conservative estimate in addition to the large possible economies in oil, gas, lignite, etc., contemplated within the plan presented.

The proposed plan should include a broader and more intensified program of education than ever before. In every technical school there should be inaugurated lecture courses on fuel conservation. Educational courses suited to their requirements should be spread throughout the country to include the teaching of the engineers and firemen who run our plants. Very great results have been obtained in the industries and also on the railroads in scientific conservation of fuel and for the good of the country's future must be carried on, intensified and expanded along rational lines.

Shortage of Coal in Europe*

It has usually been thought that with the coming of peace, despite the appalling destruction of French collieries, the difficulty of Europe supplying itself with coal would pass away. The destroyed mines of France produced 20 million metric tons (of 2205 lb.) in 1913, but even this enormous loss of coal-producing capacity represented only 3 per cent. of the total production of Europe which in 1913 was 730 million metric tons, so this loss has a relatively small effect on European coal supplies as a whole; there are other greater factors in the deficiency of production. While there was virtually no destruction of the Belgian coal mines, of which the Germans evidently expected to retain possession, and Silesian, Polish and the Bohemian mining districts have been, and still are, affected by the military fighting, the most important of all effects on production in Europe is that of the general unrest of labor and changes in labor conditions which have brought about a serious lessening of coal production. The cost of production is from 75 to 150 per cent. greater than in 1913, in the various countries, due to tremendous increases in labor and material.

Perhaps the most serious changes, because of the magnitude of the British coal industry, are those taking place in Great Britain, which in 1913 produced 287 million long tons. Great Britain has always been the largest coal-exporting nation of the world. In 1913 it exported 77 million long tons. The output in the year beginning July 16 next, when the miners' working day is to be shortened, will be about 70 million tons less than that of 1913.

If the restrictions in the consumption of coal are removed on the basis of internal consumption of 1913, this would leave but 7 million tons for export. As France, Italy, Sweden, Norway and Spain have largely been dependent on Great Britain for fuel, it can be realized that the situation is serious.

The consumption in France before the war was 62 million metric tons and the production 41 million tons. It imported 18,693,000 tons of coal, 3,010,000 tons of coke and 1,086,000 tons of briquets; exporting 1,742,000 tons of coal, coke and briquets, the total fuel imports exceeded the exports to the amount of 21 million tons. The destroyed mines in northern France produced 20 million tons, so that if the consumption of France within the pre-war boundaries were the same now as it was then, there would be a deficit of 41 million tons.

The taking over by France of Alsace and Lorraine and its occupation of the Saar district has materially altered the fuel needs. The Saar produced in 1913, 17,500,000 tons, but the labor situation has lowered the production to the rate of about 12 million tons. Estimates of coal production for the coming year were 28 million tons to 38 million tons, but owing to the shortness of hours and labor unrest, the production may fall below 20 million tons, which was the output of the undestroyed mines before the war.

Contrary to the general impression, the coal mines of Belgium were not destroyed by the Germans. The misapprehension doubtless arises because the Germans did destroy industrial plants, especially iron and steel, in the vicinity of the coal basins. The outlook for immediate improvement in production is not hopeful, although there will be some increase. The total deficiency on a 1913 basis of consumption in Belgium is about 13 million tons.

Of the great allied nations Italy is in the worst situation as regards fuel. In 1913 it produced but 773,000 tons of coal and imported in that year from Great Britain 10 million tons of coal, coke and briquets. During the war its output of low-grade anthracite and lignite was increased to a couple of million tons, but at high cost, to take care of the shortage of import coal.

Spain produced before the war a little over 4 million tons of coal yearly and is said to have increased its output materially during the war. In 1913 it imported from Great Britain 3,649,000 tons. Its natural resources are limited and it must continue to import a large proportion of coal for its consumption.

Holland produced 2,065,000 tons in 1913, but imported about 12 million tons, of which 2,018,000 tons came from Great Britain, the balance chiefly coming from Germany. Norway, Sweden and Denmark produce a negligible quantity of coal, as is also the case in Switzerland, which was supplied from Germany. The former countries imported from Great Britain in 1913, as follows: Norway, 2,298,000 metric tons; Sweden, 4,563,000 metric tons; Denmark, 3,034,000 metric tons; total 9,895,000 metric tons.

The former German Empire was a close second to Great Britain in coal output, producing in 1913 190,109,000 tons of bituminous coal and 87,233,000 tons of lignite (brown coal). The new German Republic will have approximately a yearly production, based on pre-war capacities, of about 124 million tons of bituminous coal and about 90 million tons of brown lignite. There was before the war sufficient surplus coal and coke to send large amounts to Belgium, Holland and France. But in March, 1919, the German coal owners in a conference with the Allies at Cologne declared that owing to the labor unrest and weakened condition from lack of food they had no coal to export over that already going to the "occupied" zones in the Rhine valley.

Political and industrial conditions in Russia, Austria and Poland are still so complicated that discussion of future supplies of fuel is not justifiable. The total deficit in western and southern Europe is estimated to be 50,060,000 long tons.

National Research Council's Bills Before Congress

The House Committee on Patents began public hearings on July 9 on three bills relating to the Patent Office. One of these bills proposes to establish a United States Court of Appeals. The second bill would reorganize the Patent Office, remove it from the control of the Department of the Interior and create an independent bureau to be known as the Patent and Trade-Mark Office. The third measure proposes to revise the salaries and create additional department heads in the patent service. All three of the measures that have been introduced are fostered by the National Research Council.

It is understood that the committee is willing to hear anyone interested and reserves to itself the right to amend the bills, which were drawn by the National Research Council.

*From a bulletin issued by the United States Bureau of Mines.

New England N. A. S. E. Convention

THE annual convention of the New England States Association of the N. A. S. E. was held in Springfield, Mass., July 8-12, with headquarters at the Bridgeway Hotel. The sessions of the delegates were held in the Mahogany Room of the Auditorium, situated a short distance from headquarters. The basement of the Auditorium was decorated and conveniently arranged for the mechanical exhibit of the New England Association of Commercial Engineers. The booths were occupied by 132 firms, displaying a large variety of power-plant equipment and engineering supplies. The exhibit was liberally patronized during the week.

The attendance of delegates was unusually large this year, every city in the New England States being fully represented. The business of the convention was conducted with harmony and dispatch. Considerable interest was manifested in a paper read by Edward H. Kearney, past national president, which dealt with the responsibility placed upon the engineer at all times, and the important part he plays in the commercial world. He drew attention to the intelligence and watchfulness necessary for him to do his job well. The paper told of the modesty of the engineer, and how his failure to advertise himself led the public to undervalue the importance and responsibility of his work. There is to be an energetic campaign the coming year in New England to boost the membership, and to this end organizers will be appointed and a prize given to the association initiating the greatest number of new members. The report of the state treasurer was most encouraging and places the financial affairs of the association on a sound basis. A vote of thanks was tendered to Walter H. Damon, the chairman of the convention committee, and to the Chamber of Commerce for their aid in making the meeting a success

The preliminary exercises, which included the formal opening of the mechanical exhibition, took place in the Auditorium on Tuesday evening, with Adelbert W. Pettie, president of the Supplymen's Association, in the chair. Mr. Pettie complimented the engineers on the large attendance of delegates, and introduced James W. H. Myrick as the master of ceremonies. Mr. Myrick presented Albert P. Langtry, Secretary of State for the Commonwealth of Massachusetts, who kindly welcomed the convention and told them that he appreciated the reading of the preamble of the organization, and said that for the mutual benefit of the employer and workman a close relationship between them should exist at all times. Major Myrick responded briefly and spoke of the high quality of the members of the N. A. S. E. as men and engineers. Bradford L. Ames gave a short history of the New England Association of Commercial Engineers and complimented the organization on its growth. Mr. Pettie closed the ceremonies and declared the exhibition formally opened.

On Thursday evening the opening ceremonies of the convention were held in the Mahogany Room of the Auditorium, Walter H. Damon presiding. Adolph Gilbert, representing the Mayor, was warm in his welcome to the delegates and visitors, and said that the past war would bring the engineer more prominence and appreciation. State President Andrew Waite spoke of the good quality and high standing of the members of the N. A. S. E. Adelbert W. Pettie said he was glad of the pleasant relations that existed between the engineer and supplyman in the New England States. Joseph Eccleston said that in the immediate future the engineer must be on the jump for greater production, which means higher wages. William J. Reynolds said that the war had fully demonstrated the efficiency of the American engineer and machinist, and that the German ships now operated by the United States are making faster time and are carrying bigger loads than ever. President Waite then appointed the necessary committees and the meeting adjourned until Friday, 10 a.m.

During the week there were several auto rides, shopping parties, sight-seeing trips and theater parties for the ladies. On Thursday and Friday evenings there was dancing in the Mahogany Room of the Auditorium. On Friday evening there was an entertainment in the Auditorium, by Billy Murray and Lou Serre, of Jenkins Bros.; James Donnelly, of the Lowell Association; Bob Jones, of the France Packing Co.; Jack Armour, of *Power*, and four enjoyable vaudeville acts. The entertainment was preceded by an organ recital by Arthur Turner, of Springfield.

SOME OF THOSE ATTENDING THE ANNUAL CONVENTION OF THE NEW ENGLAND STATES ASSOCIATION N. A. S. E.

On Saturday morning the company took a boat ride to Riverside Park. There was a ball game between the engineers and supplymen, and other sports. The festivities wound up with an old-fashioned Rhode Island clambake.

At the closing session of the delegates the following state officers were elected: Warren H. Goodrich, president, Stamford, Conn.; Elmer Dean, vice-president, Springfield, Mass.; Truman L. Tyler, secretary, Taunton, Mass.; Walter H. Damon, treasurer, Springfield, Mass.; John R. Graham, conductor, Fall River, Mass.; Charles Wolf, doorkeeper, New Bedford, Mass. The officers were installed by Past National Presidents W. J. Reynolds and Herbert Kelsey.

The New England Association of Commercial Engineers elected its officers as follows: Harry A. Atkinson, president, Charlestown, Mass.; A. H. Merrihew, Boston, Mass.; James W. H. Myrick, treasurer, Boston, Mass.; Charles F. Ceilley, William J. Naughton, Adelbert W. Pettie, directors.

National Vice-President John J. Calahan, of New Jersey, gave a short address at the entertainment on Friday night, and between the acts gold wrist watches were presented to retiring President Waite and retiring Secretary Henderson of the engineers, and a solitaire diamond ring to retiring President Pettie of the commercial engineers.

Worcester, Mass., was selected as the next convention city in July, 1920.

Railroad Tube Through a Mine Shaft

A feature of the $6,000,000 power plant now being erected at Springdale, Penn., by the West Penn Power Co., is the construction of a tube under the Allegheny River. A vein of coal extending under the river at this point will be mined by the company. As the coal is removed, the shaft will be finished to make it suitable for a double-track railroad tube. The tunnel will be used to convey coal to the plant, which is equipped to consume 40 tons per hour.

One of the many freak vessels produced by the British during the war is the floating electric power station officially known as "C. D. 258," says *Indian Engineering*. Its function was to supply electric current as and where required for the miscellaneous operations in connection with docks, harbors and canals used for military transport. At a distance this vessel might pass for a gunboat without guns; technically, it is described as a steel barge. Amidships is a complete electric power station of 1000 hp. designed so that practically any type of electrical installation can be fed from this source. Two oil tanks, each with a capacity of 20 tons, and an electrically driven workshop with lathe, drilling machine and other repair plant, complete the main part of the equipment. While this universal electric provider is the direct outcome of war conditions, similar equipments are likely to be very useful in the construction of sea and river works. They are also worth considering for the permanent supply of electricity to riverside towns, where, owing to the nature of the subsoil and other local conditions, an ordinary power station would be difficult to erect on a site convenient for water and fuel supply. In remote parts of the world a floating oil-power electric station could probably be installed and run much cheaper than a land station.

Men who try to do something and fail are infinitely better than men who try to do nothing and succeed.

In the several Swiss and French technical journals an account has been given of some passenger cars intended for use on the railways in Saxony and Prussia, which have some features of interest, says the *Electrician*. On these cars the Dieselmotor is directly coupled to a dynamo which in turn supplies motors equipped with separate excitation on the Ward-Leonard system. There are cabins at each end of the cars, the engines being in the middle, and a total of 80 passengers seated can be accommodated. The weight of the complete car, unloaded, is 64 tons. The Diesel motor is rated at 200 hp., working at 440 r.p.m., and can give up to 250 hp., at short overload. A speed of 45 miles per hour is obtained on the level. The generators coupled to the Diesel engines are of the 8-polar type and are rated at 190 kw. hourly and 140 kw. for continuous running. They operate at 300 volts. In addition to the 7.5 kw. separate exciter there is a battery of 35 cells of 95 ampere-hour capacity which the exciter charges. The traction motors develop 360 hp. on the one hour rating and 160 hp. continuously.

The cruelest devastation in Belgium was not military, but was the deliberate destruction of industrial plants. German wrecking crews made incursions into the steel plants and used either dynamite or a destructive weapon they called the "sheep." With dynamite they disembowled furnaces and foundations. The "sheep" are heavy pieces of steel which were hoisted above machinery marked for destruction, and then allowed to fall from a height, with the result that in one instant these delicate and intricate machines were smashed into fragments. The damage at the big plant of Ougree-Marhaye, which before the war employed 9000 men, is estimated at $10,000,000. At Cockerill, a plant then employing 11,000 workers, the damage was $15,000,000.

The demand for telephones in Japan is so great that when one subscriber is ready to give up his telephone he sells it through a broker, there being a regular market value on the phone. At the end of 1917 there were 152,000 persons awaiting the installation of telephone instruments.

Personals

C. D. McClary, who has been connected with the Western Electric Co. in its various branch offices for several years, has been made sales manager of the Pittsburgh office.

Joseph J. Nelis, for the past year with Engineering Section, Emergency Fleet Corporation, Philadelphia, Penn., has accepted a position with the Power Specialty Co., 111 Broadway, New York, as marine representative for Foster boilers, superheaters and air heaters.

Engineering Affairs

The Indiana State Association, N. A. S. E., held its fifteenth annual convention at Terre Haute, June 26-28, at which the following officers were elected: President, A Buldus, of Indianapolis; vice president, William Backle, of Evansville; secretary, A. N. Barnes, of Terre Haute; treasurer, E. G. Heeger of Evansville; conductor, John Vossler, of Richmond; doorkeeper and state deputy, Frank Clifford, of Kokomo.

The Cape May (N. J.) Association of the N. A. S. E., was instituted on the evening of July 7 by District Deputy John J Reddy, assisted by W. J. Reynolds, Chairman of the National Board of Trustees. The following officers were duly installed: President, Benjamin Shertinlief; vice president, Walter Davis; recording and corresponding secretary, F. C. B. Speace; financial secretary, Harry Balm; treasurer, Coleman Camp; conductor, Rufus Cox; doorkeeper, Charles Swain; trustees, Albert Shertinlief, George Settle, G. F. Eldredge. This new association has started off favorably, and there is great hope for its success and expansion.

Business Items

The Central Station Steam Co., Detroit, Mich., has opened a branch office at 902 First National Bank Building, Chicago, with W. K. Abernethy, formerly manager of the Minneapolis office, in charge.

The C. & G. Cooper Co., Mt. Vernon, Ohio, has gotten out a richly illustrated 24-page booklet in colors, entitled "Our Bit." The book tells in brief the story of the company's part in the war. It is dedicated to its soldiers and workmen as a memorial to the men who went to war and those who stayed and worked to provide the machinery essential to warfare.

The Chicago Pneumatic Tool Co. announces the apointment of L. C. Sprague, formerly district manager of sales at New York, as manager of Western Railroad sales, with headquarters at Fisher Building, Chicago, and H. G. Barbee as manager of Eastern railroad sales, with headquarters at 52 Vanderbilt Ave., New York City. Nelson B. Gatch, formerly district manager of sales at Chicago, has been appointed district manager of sales at New York, succeeding Mr. Sprague. Announcement of Mr. Gatch's successor at Chicago will be made later.

The Merchants and Manufacturers' Exchange of New York has taken over Grand Central Palace for the purpose of turning it into a mammoth trade clearing house to be known as the International Material Handling Machinery and Factory Appliance Exchange. The Nemours Trading Corporation owns and controls the Merchants and Manufacturers' Exchange of New York, which has branches in all the leading cities and counties in the world. To this clearing house therefore will come inquiries from many parts of the world where machinery and other commodities are desired. Both large and small concerns whose products will stand examination and comparison may secure space in the various permanent expositions at a moderate price per annum. C. R. Ringenberg is secretary-manager of the Exchange, and prior to the opening may be reached at Suite 421, 405 Lexington Ave., New York City.

Trade Catalogs

The Carbo-Hydrogen Co. of America, Benedum-Trees Building, Pittsburgh, Penn., Catalogue, 6¾ x 9 in.; 27 pages, illustrated; describes the use of carbo-hydrogen apparatus for cutting steel and wrought iron.

The Peerless Superheater Co., Inc., New York City, has issued a bulletin of useful information on "Peerless All Steel Superheaters." Six plates showing line sections for the different types and makes of boilers are given. A copy of the bulletin may be had upon request.

The Combustion Engineering Corp., New York City, has issued Bulletin S-1 on the C. E. C. Tube Scraping Device, which describes a new and novel method of scraping the cinder and ash from the boiler tubes. The bulletin is nicely illustrated and will be sent to anyone free upon request.

Dayton-Dowd Co., Quincy, Ill., has issued its 15-page bulletin No. 240, showing its redesigned line of type CS single-stage, double-suction centrifugal pumps, with table giving the capacity, speed and efficiency of the different sizes. A page of useful engineering information is also given.

The Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has recently issued the following bulletins: No. 1105 on "Stationary and Portable Air Compressor Equipments"; No. 1816 on "Crushing Rolls"; No. 1096-A on "Direct Current Motors and Generators." Copies of these bulletins may be had free upon request.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7 80@7 95
Stove	7 95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2 15@2.75	$2 75@3.25
Philadelphia, gross tons	4 27@4.95	5.95@5.50
New York, gross tons	4 62@5 29	5.29@5.85
Alongside Boston (water coal), gross tons	6.10@6 85	6.90@7.55

Pocahontas and New River are quoted at $4·70 @5.25 f.o.b. Norfolk and Newport News, Va., for spot coal, and $7.20@8.60 alongside Boston, these prices being on a gross ton basis.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5 95	$7 80	Pea	5.10	6.85
Egg	6 15	8.00	Buckwheat	3 40	5 15
Stove	6.40	8.25	Rice	2 75	4 50
Chestnut	6.50	8.35	Barley	2.25	4.00

Bituminous

	Spot
South Forks	$2 95 @ $3 25
Cambria County (good grades)	2.75 @ 2.95
Clearfield County	2 50 @ 2 75
Reynoldsville	2 50 @ 2 75
Quemahoning	2.75 @ 2.95
Somerset County (best grades)	2.50 @ 2.75
Somerset County (poorer grades)	2.15 @ 2 35
Western Maryland	2 25 @ 2.50
Fairmont	1.90 @ 2.25
Latrobe	2.10 @ 2 25
Greensburg	2 35 @ 2 50
Westmoreland	2 60 @ 2.75
Westmoreland run-of-mine	2.35 @ 2.50

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide		Line	Tide
Broken	$5.95	$7 80	Buckwheat	$3.40	$4 45
Egg	6 05	7 90	Rice	2.75	3 65
Stove	6 30	8 15	Boiler	2.50	3 50
Nut	6 40	8 25	Barley	2.25	3 15
Pea	5 00	6 60	Culm	1 25	2.15

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3 25
Mine-run	2 35@2 50	3.00
Screenings	1 85@2 20	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2 45	$2 75	$2.40
Black Creek and Cahaba	3.45	3 75	3.05
Jagger - Pratt Corona	2.85	3.05	2.45
Blacksmith	...	5.25	.....

Domestic quotations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3.95@$4 60
Corona	3 50
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

Franklin County		Mt. Olive and Staunton	Standard
Prepared sizes, lump, egg, Nos. 1 and 2 nut	$2.75	....	....
Williamson County			
Prepared sizes, lump, egg, nut	$2.55	$2.55	$2 00@2.25
Mine-run	2.35	2.20	1.60@1.75
Screenings	2.20	2.05	1.15@1.30
3-in. lump	....	2.30	
2-in. lump	....	....	1.75@1.90

Williamson-Franklin rate to St. Louis is $1.07; other rates 92½c.

New Construction

PROPOSED WORK

Me., Sanford—The Sanford Mills, c/o Lockwod-Greene Co., 101 Park Ave., New York City, will install a steam heating system in the 1 story dye house which they plan to build. Total estimated cost, $200,000.

Mass., Holyoke—Hall's Dairy, Inc., will install a steam heating system in the 2 story, 60 x 75 ft. building which it plans to construct on Sargeant St. Total estimated cost, $70,000. G P. Alderman & Co., People Savings Bk. Bldg., Arch.

Mass., Worcester—The Walden-Worcester, Inc., 72 Commercial St., will install steam heating and power systems in the 4 story, 56 x 400 ft. factory which it plans to build on Shrewsbury St. Total estimated cost, $200,000.

Conn., New Britain—St. Mark's Episcopal Congregation, 21 Washington St., will install a steam heating plant in the 100 x 100 ft. church which it plans to build. Total estimated cost, $100,000. Carrere & Hastings, 52 Vanderbilt Ave., New York City, Arch.

Conn., New Haven—The Grace Hospital Association, 1418 Chapel St., received lowest bid for building a 5 story, 100 x 140 ft. hospital on Orchard St., from Dwight Bldg. Co., 24 Center St. A steam heating system will be installed. Total estimated cost, $300,000.

Conn., New London—W. T. Murphy, 143 Bank St., will install a vacuum heating system in the 3 story, 70 x 165 ft. theatre which it plans to build on Bank St. Total estimated cost, $125,000. H. R. Brewster, 295 East 17th St., Brooklyn, N. Y., Arch.

N. Y., Brooklyn—The Jewish Orphan Asylum, Dumont Ave., will install a steam heating plant in the 3 story, 65 x 95 ft. asylum which it plans to build on Dumont Ave. between Elton and Linwood St. Total estimated cost, $115,000. E. M. Adelsohn, 1778 Pitkin Ave., Engr.

N. Y., Brooklyn—The New York Telephone Co., 15 Dey St., New York City, will install a steam heating system in the 4 story, 60 x 125 ft. exchange which it plans to build at 14th Ave. and 41st St. Total estimated cost, $200,000. McKenzie, Voorhies & Gmelin., 1123 B'way., New York City, Engr.

N. Y., Brooklyn—The New Zion Hospital, 2140 Cropsey Ave., Bensonhurst, will install a steam heating system in the 4 story, 48 x 135 ft. hospital which it plans to build at 46th St. and 17th Ave. Total estimated cost, $250,000. Shampan & Shampan, 50 Court St., Arch.

N. Y., Central Islip—The State Hospital Commission, Capitol, Albany, received bids July 1 for installing coal and ash handling apparatus in the Central Islip State Hospital, here, from the Guarantee Construction Co., 140 Cedar St., New York City, $59,350; R. H Beaumont, Drexel Bldg., Philadelphia, Penn., $68,825; Giffin-Wood Co., Hudson, $87,000; new boilers, stokers, etc., from the Austin Heating Co., 121 West 42nd St., New York City, $89,375 and W. B. Armstrong Co., 3 Fulton St., Albany, $94,942. Noted July 1.

N. Y., Hudson—The State Hospital Commission, Capitol, Albany, plans to replace underground steam and water mains and heating equipment in the training school here. Estimated cost, $15,000.

N. Y., Jamestown—The Art Metal Construction Co., Jones St. and G Ave., will install a steam heating system in the 4 story, 120 x 380 ft. factory, which it plans to build. Total estimated cost, $550,000. Lockwood-Greene Co., 101 Park Ave., New York City, Engr.

N. Y., Long Island City—The Patterson-Sargent Co., 8 Jay St., New York City, will install a steam heating system in the 4 story, 40 x 110 ft. addition which it plans to build to its factory on Van Dam St and Borden Ave., here. Total estimated cost, $200,000. Ballinger & Perrott, 47 West 34th St., New York City, Engr.

N. Y., Lowville—The Lowville Milk & Cream Co., operated by the Dairymen's League, will rebuild its plant recently destroyed by fire, entailing a loss of $15,000. An engine, boiler and an ammonia cooling system will be installed in same.

N. Y., New York—Buckley-Newhall Co., 125th St. and 5th Ave., will install a steam heating system in the 12 story, 100 x 125 ft. department store which it plans to build on 6th Ave. and 41st St. J. B. Snooks Sons, 261 Broadway, Engr.

N. Y., New York—The Cresent Realty Co., 26 East 23rd St., will install a steam heating plant in the 16 story, 150 x 200 ft. hotel which it plans to build on 5th Ave. and 50th St. Total estimated cost, $500,000. Warren & Clark, 108 East 29th St., Arch.

N. Y., New York—The Factory Construction Co., 41 Court St., Brooklyn, will install a steam heating plant in the 3 story, 95 x 175 ft. garage which it plans to build at 323 West 90th St. Total estimated cost, $100,000. F. S. Parker, 44 Court St., Brooklyn, Arch.

N. Y., New York—Lehn & Fink, 120 William St., will install a steam heating system in the 15 or 20 story office building which they plan to build on Greenwich and Morton Sts. Total estimated cost, $1,000,000. Buchman & Kahn, 56 West 45th St., Engr.

N. Y., New York—D. Neenan, 1966 B'way., will install a steam heating system in the 6 story, 90 x 100 ft. garage which it plans to build at 430-436 West 55th St. Total estimated cost, $200,000. J. C. Cocker, 2017 5th Ave., Arch.

N. Y., New York—The New York University, University Heights, will install a steam heating system in the 2 and 3 story addition which it plans to build. Total estimated cost, $500,000. Crow, Lewis & Wick, 200 5th Ave., Engr.

N. Y., New York—N. C Partos, c/o L. A. Sheinart, Archt., 192 Bowery, will install a steam heating system in the 3 story, 75 x 197 ft. post office which he plans to build at 122 East 23rd St. Total estimated cost, $150,000. United States Government, Lessee.

N. Y., New York—The Webster Apartments, 280 Madison Ave., will install a steam heating system in the 13 story, 98 x 120 ft. hotel which they plan to build at 415 West 34th St. Total estimated cost, $528,000. Parish & Shroeder, 280 Madison Ave., Arch.

N. Y., New York—Wurlitzer & Co., 113 West 40th St., will install a steam heating plant in the 15 story, 50 x 85 ft. office and loft building which it plans to build at 119 West 41st St. Total estimated cost, $600,000. Maynicke & Franke, 25 East 26th St., Engr.

N. Y., Olden—The village bd. appointed W. B. Snyder, John Simme and others as a committee to obtain plans and estimates for water power developments and lighting system Estimated cost, $100,000. Engineer not selected.

N. Y., Oneonta—Education Department, Education Bldg., Albany, received bids for the installation of boilers at the State Normal School here, from C. H. Darmstadt, 352 West 43rd St., New York City, $16,000 and W. Devendorf, 470 Court St., Rochester, $16,990.

N. Y., Rochester—Rosenberg Bros. & Co. will install steam heating and ventilating systems in the 4 story, 55 x 299 ft. addition which they plan to build to their factory at Fashion Park. Estimated cost, $20,000.

N. Y., Salamanca—The Board of School Commissioners rejected bids for installing new heating and ventilating systems in the Maple St. School. Work will be re-advertised on contract at estimated cost, $16,000. Noted June 10.

N. Y., Saranac Lake—The Marr, Gordon Co., Inc., Au Sable Forks, is in the market for granite cutting machinery and electric motors.

N. Y., Westfield—The Board of Education plans taxpayers' election July 10 to vote on $15,000 bonds for installing a heating and ventilating system in District No. 1 school.

N. J., Camden—The Broadway Trust Co., 1009 Broadway, will install a steam heating plant in the bank which it plans to build at 1009 Broadway. Total estimated cost, $200,000. P. Merz, Pennsylvania Bldg., Philadelphia, Penn., Arch.

N. J., Camden—The Committee of Streets & Highways, Committee Room, City Hall, will soon award the contract for 2 boilers for an asphalt plant and 4 draught horses.

N. J., Hoboken—L. Newman & Co., Willow Ave., will install a steam heating plant in the 6 story, 50 x 65 x 140 ft. factory which it plans to build on Ferry St. and Willow Ave. Total estimated cost, $200,000. Starrett & Van Vleck, 18 West 40th St., New York City, Engr.

N. J., Newark—Max Spiegel, Strand Theatre Bldg., New York City, will install a steam heating system in the 1 story theatre which he plans to build on Broad St., here. Total estimated cost, $100,000. T. W. Lamb, 644 8th Ave., New York City, Arch.

N. J., Plainfield—The Board of Education will install a steam heating plant in the 2½ story, 55 x 150 ft. school which it plans to build on Emerson Ave. Total estimated cost, $140,000. Wilder & White, 50 Church St., New York City, Arch

N. J., Trenton—The City Commission plans to purchase several thousand dollars worth of new machinery for the city pumping station. J. Ridgeway Fell, 134 North Clinton Ave., Engr.

N. J., Woodbury—The First National Bank of Woodbury will install a steam heating plant in the 1 story, 35 x 106 ft. bank which it plans to build. Total estimated cost, $125,000. C. R. Peddle, 136 South 4th St., Philadelphia, Penn., Arch.

Penn., Coatesville—W. F. B. Boogar will soon award the contract for installing a steam heating plant in the 2 and 3 story, 150 x 200 ft. hotel, theatre and stores which he plans to build on 1st Ave. and Main St. Total estimated cost, $150,000. Stuckert Co., 1420 Chestnut St., Arch.

Penn., Harrisburg—The York Haven Water & Power Co., York Haven, will build a transmission line from Middletown to Anville. Estimated cost, $80,000. Work will be done by day labor

Penn., Philadelphia—The Vigogne Mills, Unity and Oakland St., will install boilers and engines, in connection with the 3 story, 65 x 250 ft. mill which they plan to build. M. Ward Erly, 1420 Chestnut St., Engr.

Md., Baltimore—The Board of Awards rejected only bid received for furnishing and erecting one 25 and one 15 kw. turbo-generator set and switchboard for the Mt. Royal Pumping Station; same being excessive Work will be readvertised. W. E. Lee, City Hall, Water Engr.

N. C., Gastonia—The Main Street Methodist Congregation will install a steam heating plant in the 1 story, 175 x 200 ft. church which it plans to build on Main St. Total estimated cost, $150,000. C. C. Wilson, 804 Palmetto Bldg., Columbia, Arch.

N. C., Warsaw—The city will receive bids until July 31 for the construction of a waterworks system, to include boiler and pump. Total estimated cost, $125,000. W. M. Piatt, Durham, Engr.

N. C., Zebulon—Bids will be received until Aug. 5, by the city for the construction of a waterworks system, to include a pumping station. Total estimated cost, $150,000. W. P. Piatt, Durham, Engr.

S. C., Florence—The city will receive bids until July 29 for furnishing and installing motor-driven air compressers, motor-driven centrifugal pumps, airlift deep well apparatus and steel storage reservoir for improving waterworks. Total estimated cost, $10,000. G C. White, Durham, N. C., Engr.

S. C., York—The City School Board will receive bids about Sept. 1 for the construction of a 2 story, 100 x 150 ft. high school. A steam heating and ventilating system will be installed. Total estimated cost, $110,000. C. C. Wilson, 804 Palmetto Bldg., Columbia, Arch.

Fla., Key West—The Bureau of Yards & Docks, Navy Department, Washington, D. C., rejected bids received June 25th for the construction of a power house, electric operating equipment and fire protection system here. Estimated cost, $105,000. Noted July 1.

Fla., Miami—J. J. Allison and C. G Fisher, 434 North Capitol Ave., Indianapolis, Ind., will install a steam heating plant in the 17 story, 90 x 557 ft. hotel which they plan to build. E. Powers, 318 Walnut St., Engr.

Tenn., Chattanooga—C. W. & G. L. Rapp, Arch., 190 North State St., Chicago, Ill., is receiving bids for the construction of a 1 story, 100 x 150 ft. theatre for the Signal Amusement Co., 719 Market St. A steam heating system will be installed. Total estimated cost, $250,000.

Tenn., Memphis—Loews Theatre Co., 1492 Broadway, New York City, will install a steam heating system in the 2 story, 100 x 100 ft. theatre which it plans to build on Union Ave., here. Total estimated cost, $300,000. T. W. Lamb, 644 8th Ave., New York City, Engr.

Ohio, Canton—The Board of Education will install a steam heating system in the 2 story, 114 x 200 ft. school which it plans to build on Vine and 16th St. Total estimated cost, $200,000.

Ohio, Cincinnati—Ascher Bros., 220 South State St., Chicago, Ill., will install a steam heating system in the 1 and 2 story, 100 x 135 ft. theatre and stores which they plan to build on 7th and Vine St. Total estimated cost, $250,000. H. L. Newhouse, 4630 Prairie Ave., Chicago, Ill., Arch.

Ohio, Cleveland—The Addison Square Investment Co., Addison Rd. and Wade Park Ave., will install a steam heating system in the 3 story, 100 x 200 ft. theatre which it plans to build. Total estimated cost, $100,000.

Ohio, Cleveland—The Arjo Realty Co., 214 Williamson Bldg., will install a steam heating system in the addition which it plans to build to its factory at 6545 Euclid Ave. Total estimated cost, $250,000. Lehman & Schmidt, 210 Electric Bldg., Arch.

Ohio, Cleveland—The Board of Education, East 6th St. and Rockwell Ave., will install a steam heating plant in connection with the 2 story, 100 x 100 ft. school which it plans to build on Eddy Rd. Total estimated cost, $250,000. H. R. McCormack, East 6th St. and Rockwell Ave., Engr.

Ohio, Cleveland—M. A. Bradley, Marion Bldg., will install a steam heating system in the 6 story, 150 x 200 ft. commercial building which it plans to build on Ontario and Fountain St. Total estimated cost, $100,000.

Ohio, Cleveland—The Euclid Prospect Corp., c/o Van Aken & Strock, 6525 Euclid Ave., will install a steam heating plant in the 12 story, 377 x 400 ft. apartment hotel which it plans to build at 2432 Euclid Ave. Total estimated cost, $4,000,000. Warren & Wetmore, 16 East 47th St., New York City, Engr.

Ohio, Cleveland—J. Glick, 10022 Euclid Ave., will install a steam heating plant in the 2 story, 80 x 270 ft. commercial building which he plans to build. Total estimated cost, $150,000.

Ohio, Cleveland—C. Graber, 15703 Detroit Ave., will install a steam heating plant in the 3 story, 67 x 94 ft. commercial building which he plans to build. Total estimated cost, $100,000.

Ohio, Cleveland—The Grace Hospital Association, 2307 West 14th St., will install a steam heating system in the addition which it plans to build to the hospital. Total estimated cost, $250,000.

Ohio, Cleveland—The Haddam Improvement Co., Hippodrome Bldg., will install a steam heating system in the 8 story, 150 x 239 ft. theatre which it plans to build on East 105th St. and Euclid Ave. Total estimated cost, $400,000.

Ohio, Cleveland—The Jones Gear Co., Guardian Bldg., will install a steam heating plant in the 2 story, 110 x 310 and 30 x 100 ft. factory and office which it plans to build on Wayside Rd. Total estimated cost, $130,000. G. A. Grieble, 517 Sloan Bldg., Engr.

Ohio, Cleveland—G. D. Koch & Son Co., 10300 Euclid Ave., will install a steam heating system in the commercial building which it plans to build at 10007 Euclid Ave. Total estimated cost, $100,000.

Ohio, Cleveland—The Ohio Athletic Association, 819 Guardian Bldg., will install a steam heating system in the 200 x 400 ft. club house and gymnasium which it plans to build. Total estimated cost, $500,000.

Ohio, Cleveland—The J. M. & L. A. Osborn Co., Superior Viaduct, will install a steam heating plant in the 2 story, 130 x 150 ft. warehouse which it plans to build on East 39th St. and Superior Ave. Total estimated cost, $300,000. G. S. Rider Co., 601 Century Bldg., Engr.

Ohio, Cleveland—K. V. Painter, Cuyahoga Bldg., will install a steam heating plant in the 10 story, 135 x 360 ft. commercial building which it plans to build on East 17th St. and Euclid Ave. Total estimated cost, $300,000.

Ohio, Cleveland—The Reserve Square Co., Schofield Bldg., will install a steam heating system in the 6 story, 100 x 300 ft. office building which it plans to build on East 11th St. and Chestnut Ave. Total estimated cost, $150,000. G. A. Grieble, 517 Sloan Bldg., Engr.

Ohio, Cleveland—The W. W. Sly Manufacturing Co., 4700 Train Ave., is in the market for an Ingersoll-Rand air compressor, type e.r. 1, St. L power, 12-in. cylinder, 10-in. stroke, 250 r.p.m., 244 cu.ft. of 80-in. air, and a 220 v. alternating current, 3 phase, 60 cycle motor of either 10-25 or 60 hp.

Ohio, Cleveland—The Temple Congregation, East 55th St. and Central Ave., will install a steam heating system in the 2 story, 100 x 200 ft. temple which it plans to build on West 107th St. and Wade Park. Total estimated cost, $500,000. Hubbell & Benes, 4500 Euclid Ave., Arch.

Ohio, Cleveland—The Wheeler Radiator Manufacturing Co., 1637 Collamer Rd., will install a steam heating system in the 4 story, 100 x 250 ft. addition which it plans to build to its factory. Total estimated cost, $250,000.

Ohio, East Cleveland—The city will install a steam heating system in the 6 story, 100 x 300 ft. hospital which it plans to build on Euclid and Prospect Ave. Total estimated cost, $250,000. Architect not selected.

Ohio, Euclid—The Board of Education will install a steam heating system in the 2 story, 75 x 100 ft. high school which it plans to build. Total estimated cost, $100,000. Knox & Elliot, 1248 Rockefeller Bldg., Arch.

Ohio, Hamilton—The city plans an election soon to vote on $600,000 bonds for the construction of a 5000 kw. lighting plant. F. E. Weaver, City Engr.

Ohio, Toledo—The Standard Oil Co., Cleveland, will install a waterworks system, to include a 15,000,000 gal. pumping plant, distribution and fire pressure system, in connection with the oil refineries, which it plans to build on the bay at Toledo. R. Winthrop Pratt, Hippodrome Bldg., Cleveland, Engr.

Ind., Hammond—Gumbiner Bros., c/o Rapp & Rapp, Archts., State-Lake Bldg., Chicago, Ill., will install a steam heating system in the 6 story, 150 x 210 ft. theatre and hotel which they plan to build on Homan and State St., here. Total estimated cost, $500,000.

Mich., Detroit—The Board of Education, 50 Broadway, received bids for installing steam heating and ventilating systems in the addition which it plans to build to Moore School on Alger and Cameron Ave., from J. W. Partlan, 51 Park Place, $56,661; R. L. Spitzley, 405 Vinton Bldg., $57,522; M. B. O'Connor, Penobscot Bldg., $61,391.

Mich., Detroit—The Board of Education, 50 Broadway, rebids for installing steam heating and ventilating systems in the addition which it plans to build to Dwyer School on Hawthorn and Caniff Ave., from J. W. Partlan, 51 Park Place, $55,295; R. L. Spitzley, 403 Vinton Bldg., $56,302; Ernst Bros., 35 Bagg St., $60,216.

Mich., Detroit—The Victor Theatre Co., 1140 Penobscot Bldg., will install a steam heating plant in the 2 story theatre, store, etc., which it plans to build on 52nd St. and Michigan Ave. Total estimated cost, $300,000. C. H. Crane and E. G. Kiehler, 2325 Dime Bank Bldg., Arch.

Mich., Highland Park (Detroit P. O.)—The Board of Education, Gerald Ave., will install a steam heating system in the 2 story, school addition which it plans to build on Waverly Ave. and Hamilton Blvd. Total estimated cost, $300,000. W. H. Adams, Vinton Bldg., Detroit, Engr.

Mich., Lansing—The city plans an election July 26 to vote on $350,000 bonds for building extensions to the electric-light plant.

Mich., Muskegon—The Continental Motors Corporation, Jefferson Ave., will build a 2 story, 180 x 500 ft. gasoline engine factory and power plant. Estimated cost, $1,900,000.

Mich., Saginaw—The Sonora Phonograph Co., 279 Broadway, New York City, will install a steam heating system in the factory which it plans to build. Total estimated cost, $1,000,000.

Mich., St. Claire—The Board of Education will install a steam heating system in the 2 story school which it plans to build. Total estimated cost, $150,000. Perkins, Fellows & Hamilton, 814 Tower Court, Chicago, Ill., Arch.

Mich., Wyandotte—The city will install a steam or hot water heating system in the 2 story, 150 x 350 ft. high school which it plans to build on Superior Ave. and 3rd St. Total estimated cost, $400,000. B. C. Wetzel & Co., 2317 Dime Bank Bldg., Detroit, Arch.

Mich., Wyandotte—B. C. Wetzel & Co., Arch., 2317 Dime Bank Bldg., is preparing plans for the construction of a 2 story, 135 x 140 ft. theatre and store building on Biddle and Maple Ave. A steam heating system will be installed. Total estimated cost, $200,000. Owner's name withheld.

Ill., Chicago—Balaban & Katz, c/o Central Park Theatre, 3535 West 12th St., will install a steam heating, refrigerating and ventilating plant in connection with the 125 x 175 ft. theatre which it plans to build on 63rd St. and Cottage Grove Ave. Total estimated cost, $1,000,000. Rapp & Rapp, 180 North State St., Arch.

Ill., Chicago—S. Birkenstein & Sons, Inc., 377 West Ontario St., will install a steam heating system in the 4 story, 100 x 330 ft. warehouse which they plan to build on Kingsbury St. near the Chicago River. Total estimated cost, $300,000. S. M. Eichburg, 64 West Randolph St., Arch.

Ill., Chicago—The Board of Education, 5 South Dearborn St., received bids installing a steam heating system in the 3 story, 169 x 263 school which it plans to build on West 18th St. and South Keeler Ave., from F. W. Lamb Co., 24 East Kinzie St., $28,550; Hanley & Co., 5 North La Salle St., $29,235; National Steam Heating Co., 1331 North Clark St., $29,434. Noted June 17.

Ill., Chicago—The Bryn Mawr Hotel Co., c/o W. W. Ahlachlager, Arch., 111 West Washington St., will install a steam heating system in the 9 story 100 x 150 ft. apartment hotel which it plans to build on Bryn Mawr and Kenmore Ave. Total estimated cost, $1,250,000.

Ill., Chicago—The Chicago Beach Hotel Co., 51st St. and Cornell St., will install a steam heating system in the 12 story, 223 x 233 ft. hotel which it plans to build. Total estimated cost, $1,250,000. J. C. Hately, Pres. G. C. Nimmons & Co, 122 South Michigan Ave., Arch.

Ill., Chicago—The Chicago Butter & Egg Board, 136 West Lake St., will install a steam heating plant in the 10 story, 55 x 80 ft. office building which it plans to build on South Water and Wells St. Total estimated cost, $100,000. Lewis & Doherty, 35 North Dearborn St., Arch.

Ill., Chicago—The Chicago Dock & Canal Co., c/o C. A. Eckstrom, Arch., 5 North La Salle St., will install a steam heating system in the 6 story, 220 x 400 ft. warehouse which it plans to build on the North Pier. Total estimated cost, $500,000.

Ill., Chicago—The Commonwealth Edison Co., 120 West Adams St., will build two 2 story, 40 x 84 ft. concrete and brick transformer stations; one at 6909 Throop St. and one at 2644 Irving Park Blvd., each to contain 3 transformers of 4,000 k.w. capacity. Estimated cost, $175,000. Holabird & Roche, 104 South Michigan Ave., Arch.

Ill., Chicago—H. F. DuPoint, c/o Foltz & Brand, Arch., 111 West Washington St., will install a steam heating system in the 2 story, 110 x 150 ft. auto sales building which he plans to build on 22nd St. and Union Ave. Total estimated cost, $125,000.

Ill., Chicago—The Illinois Women's Athletic Club, 17 North State St., will install a steam heating plant in the 12 story, 125 x 220 ft. residential club which it plans to build on Rush and Pearson St. Total estimated cost, $1,000,000. Marshall & Fox, 721 North Michigan Blvd., Arch.

Ill., Chicago—R. Levine, 6957 South Halsted St., will install a steam heating plant in the 3 story, 175 x 175 ft. theatre, stores, etc., which he plans to build on Halsted and 70th St. Total estimated cost, $225,000. J. L. Koster, 6947 South Halsted St., Arch.

Ill., Chicago—The Pettibone-Mulliken Co., 725 Marquette Bldg., will install a steam heating system in the steel foundry which it plans to build. Total estimated cost, $200,000. Westinghouse, Church & Kerr, 37 Wall St., New York City, Engr.

Ill., Chicago—N. Thomasson, 4813 North Kedzie Ave., will install a steam heating system in the 3 story, 125 x 175 ft. theatre which he plans to build on Kedzie Ave. and Ainslie St. Total estimated cost, $375,000. Foltz & Brand, 111 West Washington St., Arch.

Ill., Chicago—The West End Hospital, 2058 West Monroe St., will install a steam heating plant in the 6 story, 36 x 150 ft. addition which it plans to build on Hoyers and Monroe St. Total estimated cost, $100,000. D. S. Klafter, 64 West Randolph St., Arch.

Ill., Joliet—L. F. Beach & Co. will install a steam heating system in the 4 story, 45 x 150 ft. department store which it plans to build on Cass St. and Chicago Ave. Total estimated cost, $150,000. D. H. Burnham & Co., 209 South La Salle St., Chicago, Arch.

Ill., Rockford—The Eclipse Stone Co. will install a steam heating system in the foundry which it plans to build. Total estimated cost, $200,000. Westinghouse, Church & Kerr, 37 Wall St., New York City, Engr.

Wis., Milwaukee—The Board of School Directors received lowest bid for installing a steam heating system in the school on Grand Ave. between 27th and 28th St., from the Downey Heating & Ventilating Co., 613 Clybourne St., Milwaukee.

Wis., Milwaukee — The Briggs-Stratton Co., Louis Ave., will install a steam heating and sprinkler system in the 5 story, 60 x 170 ft. addition which it plans to build to its factory on Milwaukee Ave. Total estimated cost, $500,000. H. J. Esser, Camp Bldg., Engr.

Wis., Milwaukee—Tharinger Bros. Macaroni Co., 1466 Holton St., will install a steam heating system in the 4 story, 120 x 130 ft. factory which they plan to build. Total estmiated cost, $125,000. C. H. Tharinger, c/o company, Arch.

Wis., Port Washington—The city will install one 600 h.p. Nordberg uniflow engine and a 500 kv.-a. generator in the 1 story, 20 x 40 ft. power house addition which it plans to build. Total estimated cost, $30,000. Douglas & Cahill, 301 Gross Bldg., Engr.

Wis., Sheboygan—The American Hide Co., c/o F. Schnellen, 1502 North 6th St., will soon award the contract for installing and furnishing all material for a steam ash chute system. E. Juul, 805 North 8th St., Engr.

Wis., Waukesha—The Board of Education has awarded the contract for installing a steam heating plant in the high school. to P. E. Mueller Co., 166 Reed St., Milwaukee. Estimated cost, $39,200

Wis., West Allis—The Board of Education plans to build a power house and install a steam heating plant in connection with the 2 story high school building which it plans to construct. Total estimated cost, $300,000. R. A. Messmer, Majestic Bldg., Arch.

Ia., Clinton—The Board of Education will install a steam heating plant in the 2 story high school which it plans to build. Total estimated cost, $300,000. Miller, Fullenwider & Dowling, 6 North Michigan Ave., Chicago, Ill., Arch.

Ia., Council Bluffs—The Council Bluffs School District plans to install a heating plant in connection with the 2 story, 100 x 325 ft. high school which it plans to build on Bway., between 25th and 26th St. Total estimated cost, $275,000. Proudfoot, Bird & Rawson, Hubbell Bldg., Des Moines, Engr.

Ia., Sac City—The Board of Education will install a steam heating plant in the 2 story, 85 x 150 ft. school which it plans to build. Total estimated cost, $100,000. Ashby, Ashby & Schulze, 178 West Jackson Blvd., Chicago, Ill., Arch.

Minn., Blooming Prairie—The School Board will install vacuum, steam heating and mechanical ventilating systems in the 2 story high school which it plans to build. Total estimated cost, $150,000. Jacobson & Jacobson, Owatonna, Engr.

Minn., Mankato—The city will soon award the contract for building 3 pumping stations in connection with improvements to the sewerage system. Total estimated cost, $20,000. F. W. Bates, City Clk.

Kan., Beloit—The Board of Education will install a steam heating plant in the 3 story, 100 x 137 ft. high school which it plans to build. Total estimated cost, $125,000. W. H. Saylor, Reliance Bldg., Kansas City, Arch.

Kan., Eldorado—The city will install a steam heating plant in the 2 story, 75 x 135 ft. memorial building which it plans to build. Total estimated cost, $100,000. G P. Washburn & Son. Ottawa. Arch.

Kan., Eldorado—The School Board will install a steam heating plant in the 2 story, 100 x 170 ft. high school which it plans to build. Total estimated cost, $175,000. W. H. Simon, Arch.

Kan., Wellington—The city will soon award the contract for installing a steam heating system in the 2 story, 120 x 190 ft. auditorium which it plans to build. Total estimated cost, $125,000. C. Boller & Bro., 508 Ridge Bldg., Kansas City, Mo., Arch.

Kan., Wichita—The American Cemetery Co., c/o G. A. Saxton, Secy., 310 North Roosevelt Ave., will install a steam heating plant in the mausoleum which it plans to build on 21st St. and Hillside Ave. Total estimated cost, $100,000. S. Lovell, 30 North Michigan Ave., Chicago, Ill., Arch.

Neb., Superior—The School Board will install a steam heating plant in the school which it plans to build. Total estimated cost, $100,000. E. Davis, Lincoln, Arch.

S. D., Erwin—The Board of Education will install a steam heating plant in the 2 story, 65 x 134 ft. school which it plans to build. Total estimated cost, $100,000. K. T. Snyder, 933 Plymouth Bldg., Minneapolis, Minn., Engr.

Mont., Butte—The Butte Elk Park Extension Mining Co., 56 Owsley Blk., will install an electric driven hoist, capacity 200 tons per hour from 2000 ft., one 1200 cu. ft. air compressor, electric driven, 1 electric driven station pump, capacity 450 gal. per minute, and 1 electric transformer to take 110,000 volts, in the copper and silver mine at Elk Park. Total estimated cost, $65,000. C. C. Whitmore, Mgr.

Mo., Mt. Vernon—The Board of Managers will soon award the contract for installing a water system consisting of a 100,000 gal. steel tank, on a 75 ft. tower, furnishing and erecting a deep well pump, steam exhaust pump, discharge and supply lines, etc. T. C. Dusenhury, Secy. Hohenschild & Pearce, Odd Fellows Bldg., St. Louis, Engr.

Mo., Mexico—The directors of Hardin College plan to build a steam heating plant, dormitory, etc., on the campus. Total estimated cost, $260,000. J. W. Million, Pres.

Mo., Waco—The Allegheny-Western Mining Co. will move the old Adams mill from Tuckahoe and erect same at Waco, and is in the market for a steam engine and boilers. W. S. Marquis, Gen. Supt.

Tex., Wichita Falls—The committee of the Northwest Texas Insane Asylum will soon award the contract for the construction of an administration building at the asylum, here, including heating plant, etc. Total estimated cost, $350,000. C. H. Page & Bros., Austin National Bank Bldg., Austin, Arch.

Okla., Berry—The city plans to improve the waterworks and electric-light plant. Estimated cost, $100,000.

Okla., Tulsa—The trustees of the Henry Kendall College, Cleland and 7th St., are having revised plans prepared for the construction of a gymnasium. Plans include the installation of a heating plant. C. E. Buchner, Chn.

Nev., Winnemucca—The Supervisors of Humboldt County will install a steam heating plant in the 2 story court house which they plan to build. Total estimated cost, $120,000. F. J. De Longchamps, Nixon Bldg., Reno, Arch.

Ariz., Morenci—The Morenci School District will soon award the contract for installing a Plenum steam heating system in the high school which it plans to build. Total estimated cost, $150,000. G. Lewis Wilson, Monrovia, Cal., Arch.

Ariz., Sacatone—The State plans to construct an 11,000 volt transmission line from here to the State Penitentiary of Florence. total distance of 25 miles. Auxiliary equipment, such as transformers, etc., will be required. Estimated cost, $50,000. Thomas Maddock, Phoenix, State Engr.

Wash., Seattle—The Seattle Engineering School, 100 West Roy St., will install a gas engine department and boiler rooms in the 3 story, 165 x 240 ft. school which it plans to build on Queen Anne Hill. Total estimated cost, $135,000. S. D. Ford, Lyon Bldg., Arch.

Ore., Pilot Rock—The city plans to install a lighting plant, to have a capacity of 25 kw. Bonds for $4000 were issued to help defray the expenses of same. J. L. Vaughn, Mayor.

Ore., Salem—The State Board of Control will soon award the contract for installing a high pressure heating plant in the State Institution for Feeble Minded. F. A. Legg, Salem, Arch.

Ore., Salem—The Willard Service Battery Co., 6th and Burnside St., plans to construct a 2 story, 40 x 80 ft. battery plant on High St. Estimated cost, $10,000.

Cal., Brawley—The State Railroad Commission has ordered the Imperial Valley Gas Co., El Centro, to improve its service at Brawley. It will be necessary to add a steam boiler, blower, calorimeter and steel gas holder.

Cal., Long Beach—The Board of Education will install a heating and ventilating system, boilers, etc., in the 3-story school which it plans to build on American Ave. Total estimated cost, $200,000. Austin & Austin, 1021 Baker-Detwiler Bldg., Los Angeles, Arch.

Cal., Los Angeles—The Board of Public Service Commissioners will soon award the contract for installing transformers and other equipment for power plant No. 2, in the San Francisquito Canyon. Estimated cost, $600,000. L. M. Anderson, Auditor.

Cal., Los Angeles—The Board of Supervisors will install a steam heating system in the recreation building and cottages which it plans to build at the County Hospital on Mission Rd. Total estimated cost, $110,000. A. M. McPherrin, Clk.

Cal., Los Angeles—The Fowler Union High School District will install a Plenum heating system in the high school which it plans to build. Total estimated cost, $150,000. Allison & Allison, 1405 Hibernian Bldg., Arch.

Cal., Los Angeles—The University of Southern California, College of Liberal Arts Bldg., 35th and University St., will install a steam heating plant and Plenum ventilating system in the 3 story, 160 x 256 ft. administration building on University Ave. J. Parkinson, 420 Title Insurance Bldg., Arch.

Cal., San Francisco—Livingston & Co., c/o G. A. Lansburgh, Arch., Gunst Bldg., will install a steam heating system in the 6 story, 50 x 120 ft. loft building and stores which it plans to build on Geary St. and Union Sq. Total estimated cost, $150,000.

N. S., Wolfville—The Wright & Joudrey Co. will soon award the contract for the construction of a concrete power dam securing 28 ft. head, power house and 3 miles of transmission line, and is in the market for one 35 ft. turbine, generator, etc. Total estimated cost, $40,000. L. H. Wheaton, Halifax, Engr.

Ont., Bridgeburg—The city plans to build a pumping station and install new intake. Estimated cost, $15,000. J. D. Fitzgibbon, Bridgebury, Engr.

Ont., Kingston—The Municipal Council plans to expend $30,000 for new purifiers, $10,000 for liners and $10,000 for generators to be installed in the gas plant.

Ont., Port Colborne—The city plans to build a waterworks system and is in the market for materials and pumping equipment. Total estimated cost, $100,000.

Ont., Sarnia—The United Theatres, Ltd., will install a steam heating plant, boiler, etc., in the 2 story theatre which it plans to build on Victoria St. Total estimated cost, $75,000. J. Myers, Gen. Mgr.

Sask., Moosomin—The Town Council plans to install an electric-light plant. Estimated cost, $50,000.

CONTRACTS AWARDED

R. I., Waverley—The town has awarded the contract for installing pumping machinery for the proposed sewerage system, to the Power Equipment Co., 131 State St., Boston, Mass. Estimated cost, $6572.

Conn., Bridgeport—E. M. Jennings, 277 Fairfield Ave., has awarded the contract for the construction of a 5 story, 110 x 170 ft. garage and auto sales building on Harrison St., to the T. J. Pardy Construction Co., 15 Fairfield Ave. A vacuum heating system will be installed in same. Total estimated cost, $175,000.

Conn., Burnside—Case & Marshall, Inc., has awarded the contract for the construction of a 1 story power house to J. H. Grozier Co., 721 Main St., Hartford. Estimated cost, $25,000.

Conn., New Haven—The Yale Tire & Rubber Co., 827 Elm St., has awarded the contract for the construction of a 48 x 48 ft. power house on Dixwell Ave., to C. W. Murdock, 185 Church St. Estimated cost, $30,000. Noted May 27.

Conn., Putnam—The Nightingale-Morse Mills, Inc., have awarded the contract for the construction of a hydroelectric plant, to the H. Wales Lines Co., 134 State St., Meriden. Estimated cost, $30,000.

N. Y., Rockaway—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of a power distribution system at the Naval Air Station, here, to the Hamilton Electric Co., 357 3rd St., Brooklyn, $43,143. Noted July 8.

N. Y., Rockaway—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for extending the heating system, here, to E. Rutzler Co., 404 East 45th St., New York City, at $11,720. Noted July 8.

N. Y., Watertown—The H. H. Babcock Co. has awarded the contract for building a brick boiler house, 25 x 45 ft., 30 ft. high, on Farwell St., to Hodge & Foster, Watertown. Estimated cost, $12,000.

Penn., Philadelphia—The Niles-Bement-Pond Co., 21st and Callowhill St., has awarded the contract for the construction of a 1 story, 44 x 60 ft., brick power house on Swanson and McKean St., to the Standard Construction Co., 1713 Sansom St. Estimated cost, $10,000.

S. C., Charleston—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the installation of boilers and superheaters, here, to Heine Safety Boiler Co., 1120 Pennsylvania Bldg., Philadelphia, Pa., $41,750. Noted July 8.

Ohio, Cleveland—The Euclid Chester Co., Guardian Bldg., has awarded the contract for the construction of a 100 x 112 ft. warehouse at 2900 Chester Ave., to the Craig Curtiss Co., Guardian Bldg. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ill., Alton—The High School Board, Woodriver, has awarded the contract for installing a steam heating system in the 2 story, 90 x 150 ft. high school which it plans to build between Woodriver and East Alton, to Elliott & Barry Eng. Co., 1426 Olive St., St. Louis, Mo. Estimated cost, $25,000.

Ill., Chicago—The American Cities Hotel Co., 111 West Monroe St., has awarded the contract for the construction of an 8 story, 150 x 160 ft. hotel, on Stony Island Ave. and the Midway to M. Rauen, 111 West Washington St. A steam heating system and mechanical refrigerator and circulating ice water system will be installed. Total estimated cost, $400,000.

Ill., Chicago—Milton S. Plotke, 2519 North Clark St., has awarded the contract for the construction of a 2 story, 100 x 125 ft. store and office building on Sheridan Rd. and Montrose Blvd., to the Barrett Construction Co., 77 East Washington St. A steam heating plant will be installed in same. Total estimated cost, $100,000.

Ill., Rock Island—The Board of Education has awarded the contract for installing a steam heating system in the 3 story, 160 x 190 ft. school which it plans to build on 18th Ave. between 33rd and 34th St., to Ward & Mahon, Rock Island, at $20,820.

Mich., Detroit—Solomon Bros. have awarded the contract for the construction of a 6 story, 130 x 950 ft. terminal warehouse on Fort and Ferdinand St., to Walbridge-Aldinger Co., 2356 Penobscot Bldg. A vacuum steam heating system will be installed.

Kan., Beloit—The Board of Education has awarded the contract for installing a steam heating plant in the 3 story, 100 x 137 ft. high school, to Smith & Wells, 418 Convention Ave., Springfield, Mo.

Wash., Kelso—The North Coast Power Co., Winlock, has awarded the contract for the construction of a brick substation, capacity sufficient to cover three 20 k.w. transformers which are to be moved from Winlock to Kelso, to N. A. Strand. Estimated cost, $40,000.

Cal., Caribou—The Great Western Power Co., 14 Sansome St., San Francisco, has awarded the contract for the construction of a large power plant, to the Stone & Webster Co., 147 Milk St., Boston, Mass.

Que., Buckingham—The Electric Reduction Co. has awarded the contract for water power development, here, to the Foundation Co., Ltd., 224 St. James St., Montreal. Estimated cost, $30,000.

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POWER

Volume 50 New York, July 29, 1919 Number 5

GUTS

By Rufus T. Strohm

The title of my verse, I fear,
May jar upon the cultured ear
And shock the squeamish and precise,
Whose speech is always over-nice;
But yet the simple truth remains
That, whether men have brawn or brains,
The thing that lifts them from their ruts
Is guts.

With purpose firm as adamant
It meets the coward's whine, "I can't,"
And in a voice emphatical
Declares the doctrine of "I shall!"
It turns the idler's "It may be"
To roseate reality,
And laughs with scorn at "ifs" and "buts,"
Does guts.

It picks the fighter from the dust
In which he falls, and cries "You must!"
Till, heartened and aroused anew,
He struggles up and battles through.
It rips the planking from the floor
And bursts the oaken prison door
That Fate or Fortune coldly shuts –
That's guts!

Largest Ice Plant in the West

By VICTOR J. AZBE
Consulting Engineer, St. Louis, Missouri

A 350-ton plant in which there has been much original development. Features are drum-type copper steam condensers, ammonia condensers made up of 8-in. pipe, an ice-making system employing 800-lb. cans, an ice-handling crane having six controls, a specially designed ice tank, flooded brine coolers using 22.6 sq.ft. of surface per ton of ice and a 15,000-ton storage house storing ice to a depth of 60 feet.

IN DENVER, Colorado, the ice plant of the Colorado Ice and Cold Storage Co. is of exceptional interest. Features that were developed in this plant are now in general use throughout the country. George L. Vail, chief engineer, has shown remarkable ingenuity during the 29 years he has had charge of the plant. Boiler room, engine room, ice tank and freezing system, ammonia condensers, steam condensers and ice storage all show characteristic individuality. It is safe to say that there was more original development in this ice plant than in any other in the United States.

The full capacity of the plant is 350 tons of ice per day, at which rate it is operated six months in the year. During the cooler six months about 210 tons of ice is manufactured per day, of which 110 tons is put in storage for summer peak loads and the rest is sold.

THE BOILER EQUIPMENT

Six boilers serve the plant, the steam pressure maintained being 130 lb. gage. Two of the boilers are of the B. & W. water-tube type, each rated at 350 boiler-horsepower. These two units are connected to an economizer. Two of the boilers are of the Parker type and of 411 hp. capacity each. The operating force were favorably inclined toward these boilers, claiming that they were good steamers and efficient. An economizer was not considered essential as the boiler proper includes an economizing element. The short stack serving these two boilers made it necessary to use induced draft. During a test period, operating the boilers at rating, a flue-gas temperature of 450 deg. F. was obtained. The other two boilers in the plant are of the Kewanee type, rated at 250 hp. each.

All boilers are hand-fired, and the grates are of the Vail nozzle type, the air openings being round, one-half inch diameter on the lower side of the grate and one-quarter inch at the top. The free air opening is 12.8 per cent. of the grate area. The fuel burned is Colorado lignite having a heat value of about 10,000 B.t.u. per lb. It is of the black variety and of higher grade than the brown Texas lignite.

Boiler-feed water is obtained from an artesian well. This water is good for boiler purposes as it practically contains no scale-forming matter. The condenser circulating water is obtained from a surface well by means of two 6-in. centrifugal pumps directly connected to turbines, each having a capacity of about 2000 gal. per min. This water is at a temperature of about 54 deg. F., summer and winter. It first passes over the ammonia condensers, leaves at about 75 deg. F., and at that temperature goes to the steam condensers. The characteristic of this water is that it begins to deposit heavy scale at a temperature of about 110 deg. F., so that the steam condensers become heavily coated in a short time.

THE FOUR REFRIGERATING MACHINES

In addition to the usual auxiliaries the engine room contains three 250-ton and one 75-ton refrigerating machines, one a cross-compound, one a simple Corliss with single-acting compressor cylinders, and two simple Corliss-driven compressors. The Corliss-engine cylinders discharge at atmospheric pressure into steam condensers. These condensers are drums 10 ft. long and 37 in. diameter made of thin-gage copper. When the plant is operated under full capacity, there are 14 of these condensers in use, and since the full plant capacity is 350 tons of ice per 24 hours, then each unit condenses steam for 25 tons of ice each 24 hours.

One advantage of these condensers is that copper is a great deal better heat conductor than iron, but their remarkable quality is their self-cleaning capacity. A demonstration for the writer's benefit proved a great surprise. From a heavily scale-coated condenser, steam was shut off but cooling water allowed to circulate. Immediately the scale began to crack and fall off and expose the clean smooth copper surface. In this way most of the scale came off, and after a few minutes the water was turned off and the steam on. This dried the surface and by tapping slightly with a wooden mallet the remaining scale fell off. The whole operation of cleaning did not require much over five minutes. Another advantage of this type of condenser is durability and eventual easy repair.

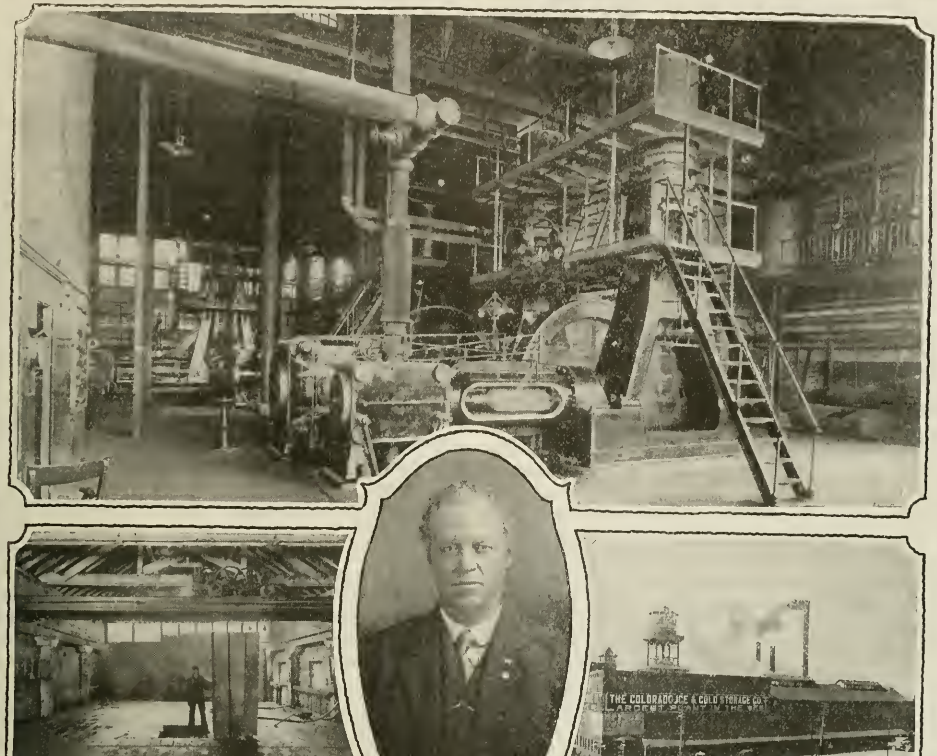
INTERESTING FEATURES OF THE FREEZING SYSTEM

The most interesting feature of the whole plant is the freezing system. Probably this is the only plant in the country having a can system freezing 800-lb. ice blocks, and it is gratifying to report that these 800-lb.

PRINCIPAL EQUIPMENT OF COLORADO ICE AND COLD-STORAGE CO. PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
1	Compressor....	Vertical.	22½x36½ in., 250 ton	Ice and refrigeration	Engine-driven	Frick Co.
1	Compressor ..	Vertical..... .	22½x36½ in., 250 ton..	Ice and refrigeration .	Engine-driven	York Mfg. Co.
1	Compressor....	Vertical......	22½x36½ in., 250 ton	Ice and refrigeration	Engine-driven..	De La Vergne Machine Co.
1	Compressor....	Horizontal....	15x36-in., 75 ton .	Ice and refrigeration	Engine-driven	Vilter Mfg. Co.
2	Boilers........	Water-tube. .	411-hp	Generate steam	130 lb. press.; induced draft	Parker Boiler Co.
2	Boilers.. ...	Water-tube	350-hp	Generate steam..	130 lb. press.; induced draft	Babcock & Wilcox Co.
2	Boilers. . .	Fire-tube .	250-hp.	Generate steam.	130 lb. press.; induced draft	Kewanee Boiler Co.
1	Air compressor	Steam-driven.	300 cu ft. per min..	Air for general purpose.	....	Ingersoll-Rand Co.
2	Pumps.. .	Centrifugal	6-in	Condenser water	Driven by 51-hp., Kerr turbine; 2100 r.p.m.	Buffalo Steam Pump Co.
2	Pumps.. ..	Centrifugal .	. ...	House supply	Driven by 23-hp. Kerr turbines; 1550 r.p.m.	Buffalo Steam Pump Co.
2	Pumps.	Centrifugal..	......	Boiler feed .	Driven by Kerr turbines.	Buffalo Steam Pump Co.
6	Pumps	Centrifugal	...	Water and brine.	Driven by 23-hp. Kerr turbines; 1550 r.p.m.	Buffalo Steam Pump Co.
1	Coal unloader..	Automatic...	40 tons per hr.....	Unload cars	....	Sterns-Rogers

Two 220-ton Vail double-can freezing systems, 800-lb. cans, six-control electric cranes; one 130-ton tank, Frick system; one 250-ton Vail type ammonia condenser one 250-ton Frick atmospheric condenser; one 250-ton De La Vergne atmospheric condenser; York flooded brine coolers.


THE COLORADO ICE & COLD STORAGE CO.
LARGEST PLANT IN THE WEST
2
6
3
4
5

FIGS. 1 TO 6. SOME VIEWS OF THE LARGEST ICE PLANT IN THE WEST. PORTRAIT OF THE CHIEF ENGINEER

Fig. 1—A view in the compressor room. Fig. 2—Ice tank with 800-lb. cans and six-control crane lifting three cans at a time. Fig. 3—Large ice plant of the Colorado Ice and Cold Storage Co. Fig. 4—Vail steam condensers of drum type. Fig. 5—Vail ammonia condenser made up of 8-in. pipe. Fig. 6—George L. Vail, chief engineer

blocks are frozen and handled with absolute success. The dimensions of the can proper are 23½ x 12½ in. at the top; 22½ x 12 in. at the bottom and 7 ft. 11 in. long. As far as effort of pulling is concerned, there is less of it here than is usually encountered with the usual system employing cans of half the size. This is primarily due to the electric crane that is employed. This crane has six controls, one for raising, one for lowering, and the others for moving lengthwise of the tank or sidewise in either direction. No pushing or guiding is required. While thawing there is no other effort required but controlling the crane. The thawing tank is located considerably below the ice tank with one side sloped so that while the cans are pulled out of the warm-water bath, they naturally take the horizontal position required for dumping.

The crane is arranged to pull three blocks, or 2400 lb. at a time. The pulling is rapid and one workman in one hour will pull from 40 to 48 blocks. As the man is getting $3.50 per day, the cost of pulling per ton of ice is between two and three cents, compared with the usual figure of 15c. per ton. Since the plant produces about 100,000 tons of ice per year, the saving by the improved system of pulling 800-lb. cans amounts to $12,000 each year.

In the Vail ice tanks there are no ammonia coils. The tank has a double bottom and is fitted with compartments. After a can is inserted into its compartment, there is an inch space between the can and the compartment wall. Brine passes from a brine cooler into the double bottom, through a ⅜-in. hole into each can compartment and up through the 1-in. space around the can. The brine level in the tank is maintained exactly at the level of the ice block when frozen. The brine overflows into a compartment, then to a tank, pump and brine cooler.

For a 50-ton system the tank occupies a space measuring in plan 27½ x 33 ft. This is remarkable concentration and is of value where real estate is expensive.

Brine is cooled in flooded coolers having 22.6 sq.ft. of surface for each ton of ice, as compared to the usual 100 to 200 sq.ft. employed. The brine cooler for the 50-ton ice tank has 160 tubes 2½ in. in diameter and 12 ft. long. The brine makes eight passages through the cooler, which occupies a horizontal position and is at all times two-thirds filled with liquid. That this liquid does not go over to the machines is proved by the fact that the discharge pressure is always at about 220 deg. F. with a condenser pressure of 150 pounds.

Through the brine cooler and the ice tank circulation of brine is maintained by turbine-driven centrifugal pumps operating against a head of about six pounds. The amount of brine circulated per minute per ton of ice is about fifteen gallons, and the temperature difference of brine entering and leaving the brine cooler is from 1½ to 2 deg. On the evaporating side of the refrigerating system the suction pressure maintained is 18 lb., but greater pressure can be obtained easily with more cooling surface.

The ammonia-condensing system consists of 29 stands of drip condensers, all being 24 pipes high and 20 ft. long. In addition the plant is equipped with condensers of Mr. Vail's own design made up of 8-in. standard pipes and arranged as shown in Fig. 5. Ammonia vapor flows successively through 14 lengths of 8-in. pipe each having 18 ft. of effective length. The 8-in. pipes are interconnected by 2-in. pipes. While the velocity in this condenser is relatively low, good results are obtained from it.

Another interesting feature is the ice storage. There are two ice-storage houses, one of 4000 tons capacity and the other, 15,000 tons. The latter probably is the largest ice-storage house in the country. When the writer visited this plant, the large ice-storage house was filled completely and ice was stacked to within two feet of the ceiling coils. Its dimensions are 175 ft. long, 60 ft. wide and 60 ft. high, which would mean that there were 30 layers and 500 tons of ice to the layer. Ice was stacked regularly and all the blocks pitched toward the center of the storage, due to pitching of the floor six inches so as to prevent any danger of the ice sliding toward the walls. The ice blocks lie directly on the floor and at the walls come close to the brine coils but do not quite touch them. The coils themselves are six inches from the wall and provide for ample air circulation.

In the large storage house there is ten miles of 1¼-in. brine piping to maintain a temperature of 16 deg. This temperature is lower than is usually considered necessary, but the result is that the ice taken out in summer is first-class and there never is any loss.

At first, objections were offered to building an ice-storage house of the height previously given. It was thought that the lower layers would not sustain the tremendous weight, but Mr. Vail proceeded systematically, testing out all objections and putting them aside. He took an ice block to a near-by machine shop and inserted it into a hydraulic press to see at what pressure it would begin to crack. The result indicated that there need be no fear on this score. Such large storage space enables the company to store cheap winter ice with a minimum of labor, and when the ice is marketed it is more desired by the trade than the ice directly from the tanks.

The Semi-Diesel Engine

By H. F. SHEPHERD

The semi-Diesel engine, hot-bulb engine, surface-combustion engine or like engine of fanciful name—what are its characteristics of construction and operation and what is its economic position? These questions are answered in the article.

COMPLETE theory of the semi-Diesel engine is still largely unwritten. At present the constructions are legion, varying not so much in mechanical details that may not be important, but rather in approach to the ideal of working involved in the stereotyped catalog or textbook description. Out of this variation arises much sales talk, and truly the purchaser without previous experience is confounded by superlatives. In what follows an attempt will be made to deal sanely with the most important variations in design and characteristics of operation from the viewpoint of the designer, also with the commercial relation between the true Diesel and the semi-Diesel.

The latter term is rather loosely descriptive of a type of engine in which vaporization of fuel (at least in some degree) and ignition are provided for by spraying the fuel charge toward a hot surface large enough to intercept all the fuel that traverses the combustion space and hot enough to produce ignition of the fuel in conjunction with the compression. The compression is lower than that employed in Diesel engines, varying actually from 150 lb. to 250 lb. per sq.in. for two-stroke-cycle types and from 180 to 300 lb. per sq.in. for four-stroke-cycle types. The injection of the fuel charge, either with or without compressed air to assist the atomization, takes place just long enough before the firing center to allow vaporization prior to ignition at that point. Solid injection of fuel or mechanical spraying is almost universal.

Economic Merit of The Type

The ever-increasing manufacture of this type is possibly sufficient evidence of its economic merit; however, the purchaser may wish to make his own analysis. This hinges on low first cost and low attendance cost. Assuming that like percentages of the initial cost may be applied to both the true Diesel and the semi-Diesel types for depreciation, upkeep, interest, insurance, etc., and dividing these fixed charges by the yearly output in horsepower-hours, the difference may be balanced against the excess fuel cost incident to operating the semi-Diesel. It is sacrcely wise to generalize on this point, as it is a local condition usually.

From the operating viewpoint, the semi-Diesel is simpler by reason of the omission of the high-pressure compressor and the gear necessary to operate the injectors and by the extreme simplicity of its injector or spray nozzle. In the plant of moderate size, where the yearly wage required to retain a man of skill and judgment may exceed the yearly fuel bill, a degree of simplicity of construction to meet the ability of the untrained operator is essential.

The semi-Diesel engine with mechanical fuel spraying exhibits one peculiarity that is not common to internal-combustion engines generally; that is, its operation is seriously influenced by its hot-surface temperature and in a lesser degree by its air-charge temperature at the time of injecting the fuel. This calls for compromise in its design and certain measures for compensation in order that it may operate satisfactorily at all loads.

A cold-air charge or a cold vaporizer at light loads will result in poor vaporization and possibly irregular ignition and the discharge of liquid fuel at the exhaust. The reader may be able to grasp this the better with the knowledge that it is a good fuel oil indeed that will yield 60 to 70 per cent. of distillate when heated to 360 deg. C. The Southwestern crudes, and especially their residuums which are sold as fuel oil, and the California fuel oils seldom yield more than 40 to 50 per cent. at that temperature. This alone would not be a difficult condition to meet, but at the other extreme the entering fuel must not meet too high a temperature.

The heavier petroleum fuels are subject to what is technically called "cracking" when exposed to high temperatures. This is essentially a rearrangement or alteration of the combinations of hydrogen and carbon which compose the fuel. The general result is the production of lighter oils (or their vapors), gas and free carbon. Controlled, this action is the basis of the Rittman process and the older Burton process for the production of larger quantities of light fuel than can be extracted from heavier petroleums by simple distillation.

Proper Control of Temperature

Repeating, the entering fuel must be subjected to a temperature no higher than necessary to vaporize it just before ignition. Some cracking will take place but it must be limited by proper control of temperature so that the least possible amount of uncombined carbon will be set free in mass form. This is not true of the Diesel engine with its air-blast injection. The reason is very simple. Oil introduced on a high-pressure air blast is so finely subdivided and distributed that each oil molecule may readily meet its oxygen and be instantly consumed. Oil introduced by a mechanical spray is delivered in microscopic drops even when sprayed at one or two thousand pounds per square inch. So-called high-pressure mechanical sprays work at from 5000 to 7000 and even 10,000 lb. per sq.in. They are not in extensive commercial use here, being too difficult to maintain, although such systems obviate serious need of careful temperature control by reason of their more perfect atomization.

If combustion begins at once on the surface of the globules of the normal moderate-pressure spray, their inner content will be "cracked," setting carbon free relatively in mass, which in this form will not burn completely in the time allowed by a single combustion period. Further, even if this does not account for all the inefficient combustion under excessive temperatures, even though each "drop" flashes into a little body of vapor if combustion begins before proper intermixing or diffusion of each small "cloud" through the air provided for its combustion, the burning on the surface will isolate the body of fuel vapor from its air with resulting escape of unburned or partly burned fuel.

The same reasoning applies to that part of the fuel that actually reaches the vaporizing surface. Vaporization and diffusion must, as far as possible, precede ignition and this necessitates temperature control between what are fortunately wide limits, but none the less limits. A red-hot vaporizer is fatal to combustion, the upper limit in modern designs being about 450 to 475 deg. C., or just below a red heat in the dark. Of course the term diffusion is not used in the scientific sense. Owing to the well-known "stormy" state of the air charge enduring after its introduction at high velocity, this action is very rapid.

THE SEMI-DIESEL AN EXPLOSION ENGINE

The semi-Diesel engine is essentially an explosion or Otto-cycle engine. Thorough preparation for instant ignition and rapid propagation is essential to the nearest possible or practical approach to this ideal. Technically, this is a more perverse problem than anything involved in the practical cycle of a Diesel engine. Practically, it is a successful alternative because its functioning devolves upon stationary or at least low-pressure elements of design that may be put into the hands of almost any class of labor.

Light-load operation with an engine of moderate compression and moderate spray pressure is made possible by deliberate retention of some of the exhaust gases; that is, the scavenging is purposely made more or less inefficient. This is accomplished in the case of the four-stroke-cycle types by the valve setting. Both exhaust and inlet are held open simultaneously for as much as 50 deg. on the suction stroke, permitting enough hot gas to be reaspirated to warm the air charge. The same result is accomplished with two-stroke-cycle designs by manipulating port dimensions and scavenging pressures and volumes. These measures, of course, reduce the available maximum mean-effective pressure, but there is little choice in the matter. The alternative is to use a high compression and a very high spray pressure, in which event the homely virtues of the semi-Diesel type are sacrificed to an ideal more satisfactorily realized in the Diesel type itself.

THROTTLES ON THE AIR INLET

A compromise is sometimes effected by fitting a throttle on the air inlet for use at light loads, thus permitting more complete scavenging for full-load operation and therefore greater capacity. It would seem that this might serve as the sole means of compensation; however, experience has shown that regulation of the air-charge temperature alone is not sufficient. There must be some direct or independent means of cooling the hot surface under heavy loads as well.

The oldest method of regulating these temperatures is the injection of water into the power cylinder with the introduction of the air charge, the quantity of water fed increasing with the load either automatically by means of a governor-controlled pump or valve or by simple manual adjustment. The former is, of course, necessary for rapidly fluctuating loads. More recently, the hot ball or vaporizer has been fitted with an annular jacket through which a sufficient quantity of water is fed to maintain it at the proper temperature. This arrangement is not automatic as built to date.

Another device is a hot ball or vaporizer in the form of a drawn-steel pot let down into the combustion chamber. The fuel is sprayed against its bottom. A jacketed cover secures the pot in place and closes the interior from the atmosphere. This pot carries a charge of mercury boiling at 360 deg. C. An excess of heat is automatically dissipated by the boiling of the mercury at a consistent rate and the condensation of the vapor against the jacketed cover above, the cool liquid falling back into the boiling liquid below.

The design of the combustion chamber has but one theoretical requirement. As much of the air as possible should be massed between the fuel injection and the vaporizer at firing time. Air isolated in clearances and pockets cannot lend its oxygen to the burning of the fuel.

In this country and abroad two-stroke-cycle semi-Diesel designs predominate. The higher cyclical temperature of the two-stroke-cycle engine for a given compression lends itself nicely to the requirements of the type, especially to light-load operation.

DESIGNS WITH CROSSHEADS AND WITHOUT EQUALLY DIVIDED

The trade is about equally divided between designs with crossheads and those without. In the case of the two-stroke-cycle engine, the situation is essentially this: Air for scavenging is usually pumped by the displacement of the crank end of the piston. If a crosshead is employed, the crank end of the cylinder may be closed off by a bulkhead in the bed and a stuffing-box. If it is not used, the space within the crank box is utilized as the scavenging-air chamber and the main bearings must be packed air-tight.

The method of accomplishing this should always be investigated. The original way was to use simple non-adjustable bushings for the main bearings, depending on their fit and lubrication for air-tightness. After slight wear, aside from the play, when air leakage develops, the oil is blown out and the lubrication is seriously hindered. Somewhat later designs use soft packing in a stuffing-box at the outside of the main journals, and possibly the best is one adapted from European practice in which snug collars are fitted to the crankshaft close up to the throws and pressed outward by springs so as to seat against shoulders in the bearing housing or bedplate. These collars are splined to the shaft or slide on pins extending from a shoulder next the web and revolve with the shaft. Seat wear is, of course, taken up laterally by the springs. This gives the designer practically a free hand in the structure of the main bearings in the case of the single-cylinder engine. Multicylinder engines with crank-case compression present a more difficult problem in the design of the center bearings. When a crosshead is employed, main-bearing design involves no other problem than a convenient and secure adjustment and the application of any chosen means of lubrication. Among these latter, splash lubrication is made possible. This may not be the most modern and elegant means of lubrication, but it is at least intensely practical under adverse conditions. Its use is not possible with crank-case compression, as the oil would pass away through the scavenging ports.

No form of fuel spray or injector may be described as the best, as what is right with one form of governing system, fuel pump or combustion chamber or even development may be entirely unsuited to another. The most essential feature is that it shall cease delivery, or cut off, without dribble or spurt immediately on completion of the pump movement. This may be shown by operating the engine pump quickly by hand. A poorly designed injection system or one in bad repair may deliver almost a continuous stream of fuel instead of an intermittent, well-timed spray, despite what may be reasonably expected from the known mechanical movement of the pump.

All oil engines should be fitted with relief valves, preferably of the spring-loaded type. A cold start, leaving unconsumed oil in the combustion chamber or derangement of the spray nozzle may produce powerful premature explosions that have been known to wring the hubs from the flywheel spokes or to sunder the engine structure in some uncanny fashion when such valves are not provided.

Heine Marine Cross-Drum Boiler

The latest design of marine boiler built by the Heine Safety Boiler Co., St. Louis, Mo., is of the cross-drum type. The boiler proper consists essentially of two flat steel rectangular box headers and a cylindrical steam drum. The main bank of 3½-in. tubes connects the two box headers, and when the boiler is set in its operating position, they are inclined at an angle of 16 deg. to the horizontal.

Above the front box header and slightly to the rear of it is placed the steam drum, which is connected to the front header by a row of nearly vertical short tubes, or nipples, and to the rear header by a row of longer tubes, which are horizontal when the boiler is set. The boiler is supported by a steel structure resting on and secured to proper foundations in the vessel.

The steam drum varies in the several sizes of boilers from 36 in. to 48 in. in diameter. It consists of a single plate steel shell of a thickness corresponding to the pressure requirements and has a double-riveted, double-butt-strapped longitudinal-riveted seam and flanged and dished steel heads, one of which has a manhole. Where the tubes enter and are secured to the shell of the drum, reinforcing plates are fitted.

Inside the drum is a steel deflection plate of sufficient length to cover the ends of the horizontal tubes and extending below the water level, its purpose being to act as a separator for the mixture of steam and water entering the drum through the horizontal tubes. The water thrown violently against this plate runs downward into the body of water below, and the steam passes along and around the ends of the plate and to the dry pipe above.

A scum pan of the usual "dish" type, with its cover plate slightly raised to produce an efficient "skimmer" effect, is located at the center of the drum exactly on the water line and piped to a surface blow outlet on the front of the drum shell.

Surge plates are fitted to check the rush of water along the drum as the vessel rolls in a seaway.

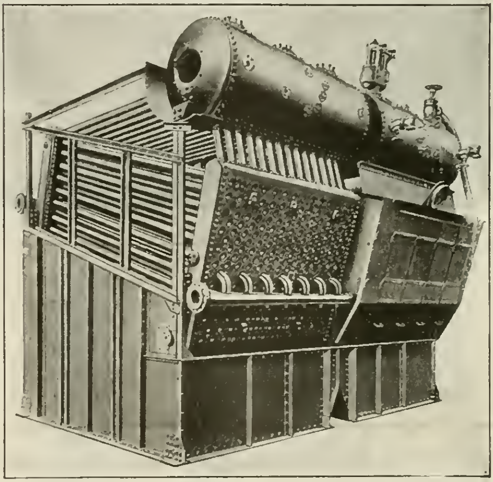
The main steam outlet is provided with a dry pipe of ample area. It is placed as near the top of the drum as practicable and has slots cut through its upper side, the area through these slots exceeding that of the outlet opening.

Zinc slabs are also fitted in the steam drum conforming to the navy standard of three-quarters of a square foot of exposed zinc plate for each 100 sq.ft. of heating surface. A pressed-steel basket catches the disintegrated zinc.

The box headers are so constructed that all seams are readily accessible for inspection and recalking without tearing away the boiler casing.

The two flat surfaces of the box headers are stayed with large hollow steel stay-bolts screwed through tapped holes in the plates and with their projecting ends riveted over on the outside. The holes through the stay-bolts are of ample size to pass freely a ⅜-in. pipe lance for soot blowing.

Superheaters of the waste-heat type for low or medium superheat are placed in the base of the uptake, as near as possible to the exit of the gases from the boiler. For higher superheat the elements are placed where they will be in contact with gases of higher temperature and are often fitted just below the middle baffle, the superheater elements passing through the 5-in. stay-tubes between the headers located outside the boiler. The right-angle bend of the superheater tubes entering the top of the front pipe header is arranged at one end of the boiler only and permits of the tubes being more easily removed and replaced than if they were straight throughout.



NEW MARINE CROSS-DRUM BOILER

The boilers are built in accordance with the rules and regulations of the United States Board of Supervising Inspectors and are approved by Lloyd's Register of Shipping and the American Bureau of Shipping.

The casing about the furnace proper is lined with refractory walls 12 in. thick, and above the lower baffle the lining is 7½ in. thick.

The furnace fronts for coal burning are fitted with balanced in-swinging doors above and below the grate.

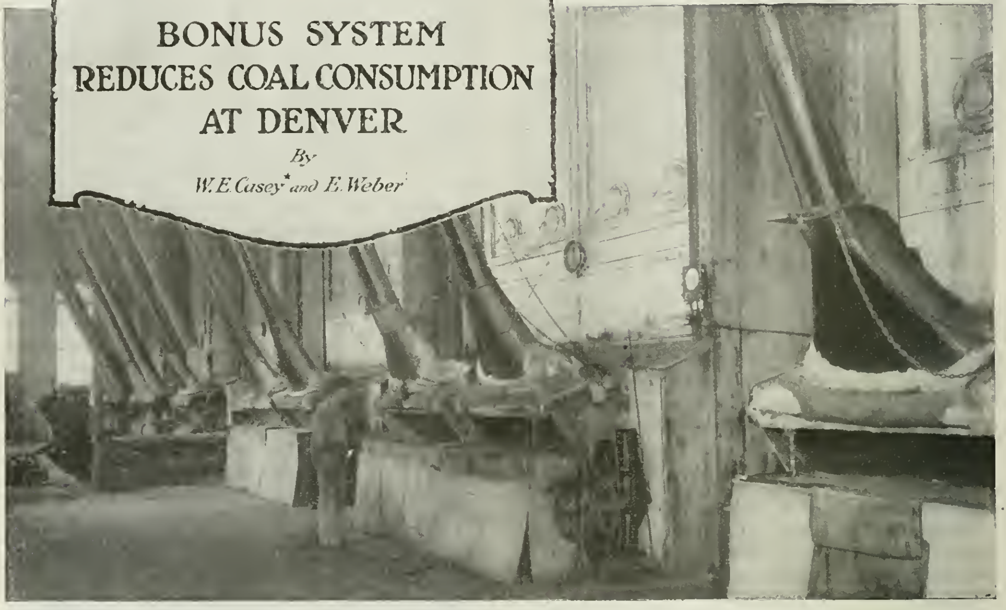
The circulation is downward in the front box header and upward in the rear box header, upward and back in in the lower majority of the bank of inclined tubes and downward and to the front in a few upper rows of inclined tubes; the steam parting from the water in the upper portion of the rear header and passing into the steam drum through the horizontal tubes as before described.

Should oil or impurities enter with the feed, the scum formed may be removed by operating the surface blow with the water level at the middle of the glass. Sediment will be thrown down in the front header, where the bottom blow is arranged to remove it.

BONUS SYSTEM REDUCES COAL CONSUMPTION AT DENVER

By

W. E. Casey and E. Weber†*



By the installation of a new turbine and the introduction of the bonus system, coal consumption on the Denver Tramway system is reduced to less than 2.5 lb. per kilowatt-hour with saving in operating expenses of about one hundred and fifty thousand dollars per year.

IN THESE days of increased cost of production and operation, it will be of interest to learn how the Denver Tramway has succeeded in improving its power plant and, in spite of the increased cost of labor and coal, has, by greatly reducing the coal consumption per kilowatt-hour, kept the burden from rising to an intolerable extent.

Shortly after F. W. Hild was appointed general manager of this company, he called in E. A. West, then efficiency engineer of the Portland Railway, Light and Power Co. and now chief engineer of the Denver Tramway, to make an investigation and report on the power situation that confronted the company. This report showed that it would be best to install a turbine of capacity sufficient to carry the maximum load of the system and in this way to obtain a better average water rate than was possible with a number of small units.

To explain more in detail the improvements that were made in the plant, it will be necessary to enumerate the apparatus formerly at the power house. At the end of the year 1915 the principal equipment consisted of: Thirteen 415-hp. and six 705-hp. Stirling boilers, all equipped with chain grates, superheaters and economizers; three 800-kw. direct-current cross-compound, engine-driven generators, one 1600-kw. direct-current, cross-compound engine-driven generator, one 1500-kw. alternating-current, cross-compound engine-driven generator, and two 2000-kw. alternating-current turbo-generators. One of the 800-kw. generators had to be "scrapped" in August, 1916.

NEW 7500-KW. TURBINE AND 300-KW. ROTARY CONVERTER INSTALLED

The new equipment, construction work for the installation of which was begun about August, 1916, included one 7500-kw. turbine, hereafter referred to as No. 8 turbine, with surface condenser, and one 300-kw. rotary converter. The turbine is shown in Fig. 1. Owing to delays in delivery, the rotary was not placed in service until March, 1917, and the turbine not until August, 1917, but during the time of construction, or rather after the fall of 1915, the power-house performance was watched closely. Suggestions made by employees were considered carefully and many were adopted. At the same time the employees received advice and instruction so as to enable them better to understand their duties.

It was recognized that to obtain the full benefit of the equipment, both old and new, a method would have to be found that would give the men some special interest in their work, and after making a careful study of the subject, a proposed bonus system was drawn up. In July and August, 1917, the power-house employees were given an opportunity to make comments on the proposed bonus scale, and with some minor changes the order was put in effect Sept. 1, 1917, in the form following:

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*Superintendent of power, the Denver (Colo.) Tramway.

†Mechanical engineer, the Denver (Colo.) Tramway.

Bonus System for Power-House Employees[1]

1. Each employee on the power-house payroll shall be entitled to a bonus, depending on the coal consumption per kilowatt-hour. The method of calculating this bonus will be explained in detail in the following paragraphs:

2. The coal used during each month shall be figured from the mine weights. The amounts of coal on hand in bins shall be estimated by the superintendent of power at the end of each month.

3. The kilowatt-hour output for the month shall be the entire amount generated for the month and shall include station power and light. The amount used for station power and light shall not exceed 2.5 per cent. of the total amount generated if No. 8 turbine is in service, and shall not exceed 4 per cent. if No. 8 is in repair. Each 5000 kw.-hr., or fraction in excess of this amount, shall be figured to increase the coal consumption by 0.01 lb. per kilowatt-hour.

4. Steam used for purposes other than power-house operation shall be credited to coal consumption; 5 lb. of steam used shall be estimated to be equal to 1 lb. of coal, or if such steam is paid for in a lump sum, then each dollar shall be considered equivalent to 1000 lb. of coal.

5. The bonus system is based on the present load characteristic and load factor; if either one or both shall change materially, it will constitute a cause for a revision of the bonus scale.

6. If the coal consumption in succeeding months varies more than 0.1 lb. of coal per kilowatt-hour, the chief engineer of the company shall make an investigation before a bonus is paid.

7. The bonus scale is based on lignite coal from the Leyden mine with a heat value of 9500 B.t.u. per lb. If other coal is used, the theoretical amount of coal used shall be figured to be in proportion to the heating value of the coal determined by a responsible chemist.

8. The amount of bonus each employee shall receive will be calculated by dividing the total bonus by the number of men on the power-house payroll. In determining the number of men on the power-house payroll, the following rules shall govern:

a. Extra men taking the place of employees on the sick list shall not be figured as an addition to the number of power-house employees unless on the power-house payroll for a full month or longer. Employees on the sick list for six days or longer shall not be entitled to a bonus, but shall be included in the number of power-house employees as long as they remain on the power-house payroll.

b. Employees taking their vacation shall be included in the number of employees on the payroll and shall receive their bonus, but in case that it is necessary to employ extra men to take the places of men absent on vacation, the total amount of wages paid such extra men shall be deducted from the total amount considered in calculating the bonuses. These extra men shall be entitled to a bonus if they are on the power-house payroll for a full month or longer; but shall otherwise be considered as extra men as outlined above.

9. If No. 8 turbine has to be taken out of service for repairs and the operating force is not at fault, the bonus shall be calculated in the following manner: The output of the old equipment shall be taken at 4 lb. of coal per kilowatt-hour and the corresponding amount of coal deducted from the total monthly consumption. The resulting quantity of coal divided by the kilowatt-hour output of No. 8 turbine shall be used to determine the bonus.

10. If No. 8 turbine has to be taken out of service for repairs due to faulty operation, the whole engine-room crew shall not be entitled to a bonus. In this case each fraction of a month needed to repair No. 8 shall be considered as a full month.

11. No power-house employee shall be entitled to a bonus if, through his fault, damage is caused to the power house or any of its equipment, and if inspection has been overlooked by the foreman to whom this employee reports, he also shall not be entitled to a bonus.

12. In case of power interruption, due to faulty operation, the bonus will be figured for the total number of power-house employees, but the particular employees at fault shall not be entitled to any bonus.

13. Payment of the bonus shall be made in the following manner: 90 per cent. of the total bonus earned will be paid out as outlined above, 10 per cent. will be retained, and this sum paid out semiannually to all men who have been on the power-house payroll for the half year or longer just preceding.

14. The following bonus scale shall be used to determine the proper amounts:

Coal per Kw.-Hr., Lb.	Total Bonus per Month	Coal per Kw.-Hr., Lb.	Total Bonus per Month
3.11 to 3.09	$2	2.75 to 2.73	344
3.09 to 3.07	4	2.73 to 2.71	382
3.07 to 3.05	8	2.71 to 2.69	422
3.05 to 3.03	14	2.69 to 2.67	464
3.03 to 3.01	22	2.67 to 2.65	508
3.01 to 2.99	32	2.65 to 2.63	554
2.99 to 2.97	44	2.63 to 2.61	602
2.97 to 2.95	58	2.61 to 2.59	652
2.95 to 2.93	74	2.59 to 2.57	704
2.93 to 2.91	92	2.57 to 2.55	758
2.91 to 2.89	112	2.55 to 2.53	814
2.89 to 2.87	134	2.53 to 2.51	872
2.87 to 2.85	158	2.51 to 2.49	932
2.85 to 2.83	184	2.49 to 2.47	994
2.83 to 2.81	212	2.47 to 2.45	1058
2.81 to 2.79	242	2.45 to 2.43	1124
2.79 to 2.77	274	2.43 to 2.41	1192
2.77 to 2.75	308	2.41 to 2.39	1262

15. If any employee of the power house should find the bonus, as figured by the auditor, not to be correct, they can appeal to the chief engineer of the company, whose decision shall be final.

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[1] Copy of Denver Tramway Standing Order. No. P. 5.

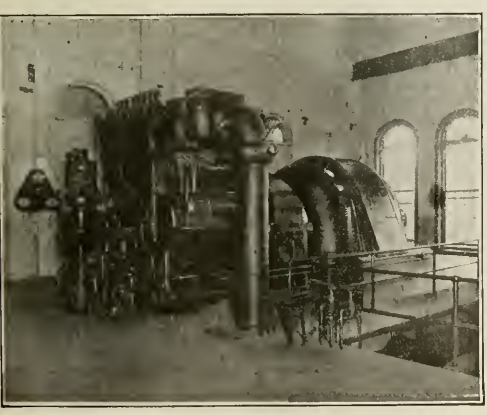


FIG. 1. NEW TURBINE AT DENVER TRAMWAY PLANT

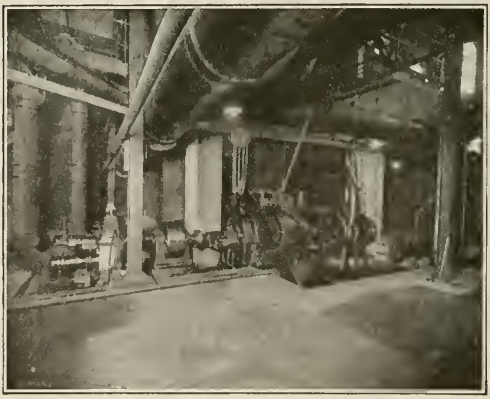
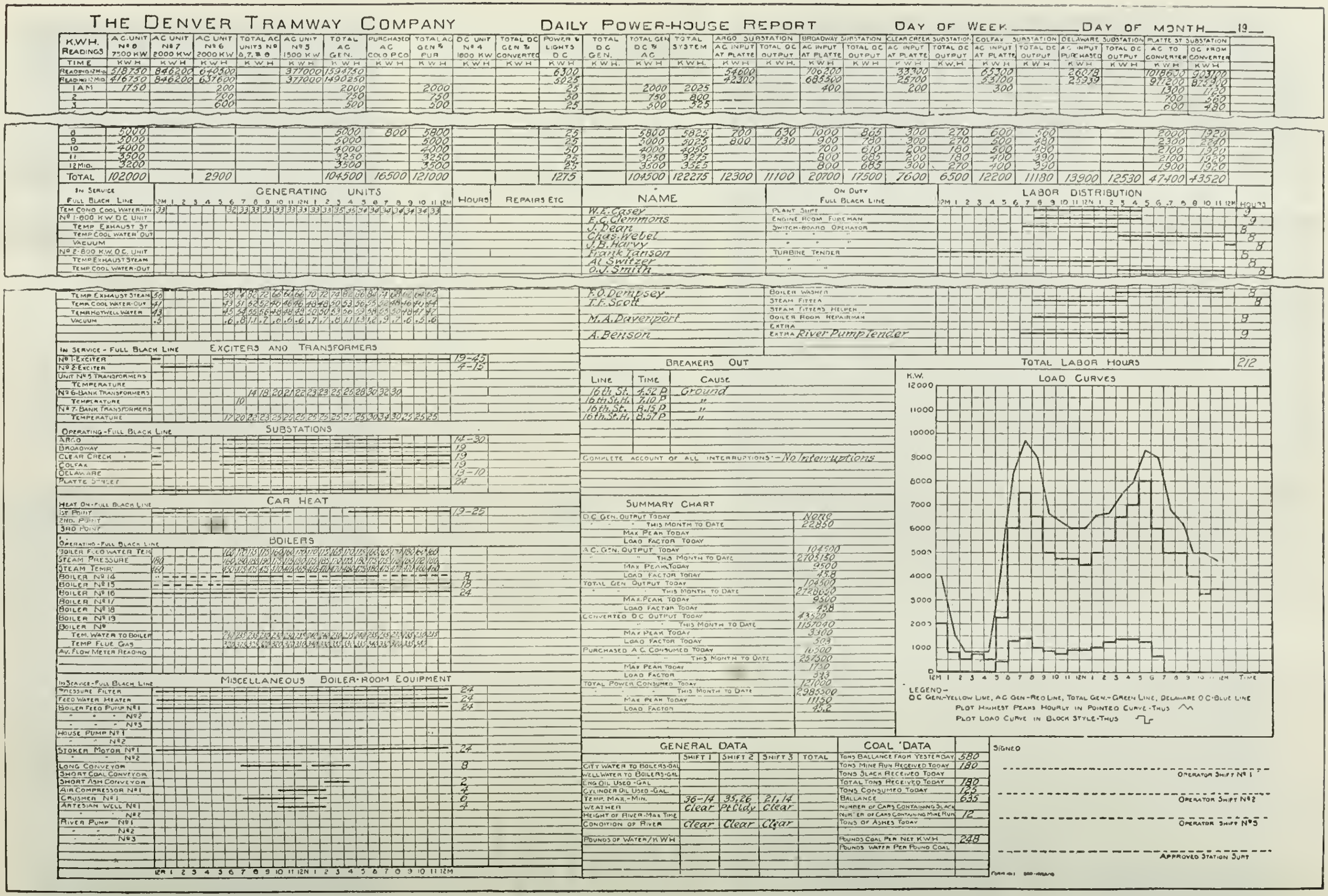


FIG. 2. AUXILIARY ROOM, BASEMENT


K.W.
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
12M 1 2 3 4 5 6 7 8 9 10 11 12N 1 2 3 4 5 6 7 8 9 10 11 12M
Time

THE DENVER TRAMWAY COMPANY DAILY POWER-HOUSE REPORT DAY OF WEEK ________ DAY OF MONTH ____ 19__

K.W.H. Readings	AC Unit No 8 7500 KW	AC Unit No 7 2000 KW	AC Unit No 6 2000 KW	Total AC Units No 6,7, & 8	AC Unit No 5 1500 KW	Total AC Gen.	Purchased AC Colo P Co	Total AC Gen & Pur	DC Unit No 4 1600 KW	Total DC Gen & Converted	Power & Lights DC	Total DC Gen.	Total Gen DC & AC	Total System
Time	KWH	KWH	KWH	KWH	KWH	KWH	KWH	KWH	KWH	KWH	KWH	KWH	KWH	KWH
Reading 12 Mid	518750	846200	640300		377000	1594750					6300			
Reading 12 Mid	416750	846200	637600		377000	1490250					5025			
1 AM	1750		200			2000		2000			25		2000	2025
2			700			750		750			50		750	800
3			600			500		500			25		500	525
8	5000					5000	800	5800			25		5800	5825
9	5000					5000		5000			25		5000	5025
10	4000					4000		4000			50		4000	4050
11	3500					3250		3250			25		3250	3275
12 Mid.	3200					3500		3500			25		3500	3525
Total	102000		2900			104500	16500	121000			1275		104500	122275

K.W.H. Readings	Argo Substation AC Input at Platte	Argo Substation Total DC Output	Broadway Substation AC Input at Platte	Broadway Substation Total DC Output	Clear Creek Substation AC Input at Platte	Clear Creek Substation Total DC Output	Colfax Substation AC Input at Platte	Colfax Substation Total DC Output	Delaware Substation AC Input Purchased	Delaware Substation Total DC Output	Platte St Substation AC to Converter	Platte St Substation DC from Converter	
Time	KWH	KWH.	KWH	KWH	KWH	KW.H	KWH	KWH	KWH	KWH	KWH	KWH	
Reading 12 Mid	54600		706200		33300		65300		26078		1018600	903100	
Reading 12 Mid	42300		685500		25700		53100		25939		971200	875900	
1 AM			400		200		300				1300	1120	
2											700	560	
3											600	480	
8	700	630	1000	865	300	270	600	560			2000	1920	
9	800	730	900	780	300	270	500	480			2300	2240	
10			700	610	200	180	500	480			2700	1920	
11			800	685	200	180	400	390			2100	1920	
12 Mid.			800	685	300	270	400	390			1900	1920	
Total	12300	11100	20700	17500	7600	6500	12200	11180	13900	12530	47400	43520	

GENERATING UNITS

In Service Full Black Line	12M	1	2	3	4	5	6	7	8	9	10	11	12N	1	2	3	4	5	6	7	8	9	10	11	12M	Hours	Repairs Etc
Tem Cond Cool Water-In	33						32	33	33	33	33	33	33	33	33	35	35	34	34	34	34	34	34	33			
No 1-800 K W D C Unit																											
Temp Exhaust St																											
Temp Cool Water Out																											
Vacuum																											
No 2-800 K.W. D.C. Unit																											
Temp Exhaust Steam																											
Temp Cool Water-Out																											
Temp Exhaust Steam	56						58	74	82	72	66	66	66	70	72	74	82	86	84	74	68	66	64	62			
Temp Cool Water-Out	41						43	51	52	52	40	46	46	48	48	50	53	56	55	52	48	46	44	44			
Temp Hotwell Water	43						45	54	55	56	48	48	49	50	50	53	56	59	58	55	50	48	47	47			
Vacuum	.5						.6	.8	1.1	.7	.6	.6	.6	.7	.7	.8	1.1	1.3	1.2	.9	.7	.6	.5	.6			

EXCITERS AND TRANSFORMERS

In Service - Full Black Line	12M	1	2	3	4	5	6	7	8	9	10	11	12N	1	2	3	4	5	6	7	8	9	10	11	12M	Hours	
No 1-Exciter																										19-45	
No 2-Exciter																										4-15	
Unit No 5 Transformers																											
Temperature																											
No 6-Bank Transformers									14	18	20	21	22	23	23	25	26	28	30	32	30						
Temperature								10																			
No 7-Bank Transformers																											
Temperature							17	20	22	23	25	25	25	25	25	25	25	25	30	34	30	25	25	25			

SUBSTATIONS

Operating - Full Black Line	Hours
Argo	14-30
Broadway	19
Clear Creek	19
Colfax	19
Delaware	13-10
Platte Street	24

CAR HEAT

Heat On - Full Black Line	Hours
1st Point	19-25
2nd. Point	
3rd Point	

BOILERS

Operating - Full Black Line	12M	1	2	3	4	5	6	7	8	9	10	11	12N	1	2	3	4	5	6	7	8	9	10	11	12M	Hours
Boiler Feed Water Tem							160	175	175	175	160	160	170	170	175	165	170	175	165	165	170	180	164	160		
Steam Pressure	180						160	180	185	190	175	175	180	175	185	170	175	180	175	175	175	180	172	180		
Steam Temp.	460						450	475	475	475	510	460	465	465	470	470	480	475	480	475	477	470	460	460		
Boiler No 14																										8
Boiler No 15																										18
Boiler No 16																										24
Boiler No 17																										
Boiler No 18																										
Boiler No 19																										
Boiler No																										
Tem. Water to Boiler							230	235	235	230	235	230	215	240	[illegible]	230	215	240	235	235	235	235	230	215		
Temp Flue Gas							[illegible]	325	325	[illegible]	320	310	310	345	335	335	[illegible]	315	345	335	320	335	[illegible]			
Av. Flow Meter Reading																										

MISCELLANEOUS BOILER-ROOM EQUIPMENT

In Service - Full Black Line	Hours
Pressure Filter	24
Feed Water Heater	24
Boiler Feed Pump No 1	24
" " " No 2	
" " " No 3	
House Pump No 1	
" " No 2	
Stoker Motor No 1	24
" " No 2	
Long Conveyor	8
Short Coal Conveyor	
Short Ash Conveyor	2
Air Compressor No 1	4
Crusher No 1	6
Artesian Well No 1	4
" " No 2	
River Pump No 1	
" " No 2	
" " No 3	

Name	On Duty Full Black Line	Labor Distribution Hours
W.E.Casey	Plant Supt	9
E.C.Clemmons	Engine Room Foreman	9
J.Dean	Switch-board Operator	8
Chas.Webel	" " "	8
J.B.Harvy	" " "	8
Frank Tanson	Turbine Tender	5
Al Switzer	" "	8
O.J.Smith	" "	8
F.O.Dempsey	Boiler Washer	8
T.F.Scott	Steam Fitter	8
	Steam Fitters Helper	
M.A.Davenport	Boiler Room Repairman	8
	Extra	
A.Benson	Extra River Pump Tender	9
	Total Labor Hours	212

BREAKERS OUT

Line	Time	Cause
16th St.	4.52 P	Ground
16th St.H.	7.10 P	"
16th St.	8.15 P	"
16th St.H.	8.57 P	"

Complete account of all interruptions: — No Interruptions

SUMMARY CHART

D.C. Gen. Output Today	None
" " " This Month to Date	22850
Max Peak Today	
Load Factor Today	
A.C. Gen. Output Today	104500
" " This Month to Date	2705150
Max Peak Today	9500
Load Factor Today	45.8
Total Gen Output Today	104500
" " " This Month to Date	2728650
Max. Peak Today	9500
Load Factor Today	45.8
Converted DC Output Today	43520
" " This Month to Date	1157040
Max Peak Today	3300
Load Factor Today	50.3
Purchased A.C. Consumed Today	16500
" " " This Month to Date	257500
Max Peak Today	1750
Load Factor	39.3
Total Power Consumed Today	121000
" " " This Month to Date	2985500
Max Peak Today	11150
Load Factor	45.2

LOAD CURVES

Legend — DC Gen. - Yellow Line, AC Gen - Red Line, Total Gen. - Green Line, Delaware DC - Blue Line

Plot Highest Peaks Hourly in Pointed Curve - Thus ⋀⋀

Plot Load Curve in Block Style - Thus ⊓⊔

GENERAL DATA

	Shift 1	Shift 2	Shift 3	Total
City Water to Boilers - Gal				
Well Water to Boilers - Gal				
Eng Oil Used - Gal				
Cylinder Oil Used - Gal.				
Temp. Max.-Min.	36-14	35,26	21,14	
Weather	Clear	Pt.Cldy	Clear	
Height of River - Max Time				
Condition of River	Clear	Clear	Clear	
Pounds of Water/K W H				

COAL DATA

Tons Ballance from Yesterday	580
Tons Mine Run Received Today	180
Tons Slack Received Today	
Total Tons Received Today	180
Tons Consumed Today	125
Ballance	635
Number of Cars Containing Slack	
Number of Cars Containing Mine Run	12
Tons of Ashes Today	
Pounds Coal Per Net K W H	2.48
Pounds Water Per Pound Coal	

Signed

- - - - - - - - - - - - - - - - Operator Shift No 1

- - - - - - - - - - - - - - - - Operator Shift No 2

- - - - - - - - - - - - - - - - Operator Shift No 3

- - - - - - - - - - - - - - - - Approved Station Supt

FIG. 3. DAILY LOG SHEET OF DENVER POWER DEPARTMENT

RECORD FORMS USED IN DENVER POWER PLANT IN CONNECTION WITH THE BONUS SYSTEM

At top, daily report on load conditions.

In center, No. 8 turbine reports, a.m. and p.m.

At bottom, temporary watt-hour reading record later transferred to log sheet.

Form 719 500 6-18

The Denver Tramway Company

CONDITION OF LOAD

Time 5.55 P.M. Nov. Date 27th 1918

	Avg Load	Max Peak	Machines in Service No. K. W. Cpy
A. C. Generated at Platte	8000	9000	#8 7500
D. C. Generated at Platte			
D. C. Converted at Delaware	1500	1650	1500
Total System Load	9500	[illegible]	9000

2 – 700 H. P. Boilers in service

1 – 700 " " Banked

Remarks 12 Cars Leyden Coal

Form 880

The Denver Tramway Company

Date 11-27-18

Daily Report of Steam Turbine No. 8, Rating 7500 K. W.

Report by F. C. Lawson Unit Started 5^{10} A.M. Shut Down 12^{55} A.M.

LOAD READINGS

TIME A. M.	7	8	9	10	11	12	1	2	
Pressure of Steam	180	185	190	175	175	180	175	185	
Pressure Degree Superheat	96	94	92	93	88	86	88	89	
" 1st Stage	46	62	44	32	30	34	32	34	
" Absolute	.8	1.1	.1	.6	.6	.6	.7	.7	
" Barometer									
" Pump	90	90	90	90	90	90	90	90	
" Bearings	25	25	25	25	25	25	25	25	
" Hydraulic Gear	90	90	90	90	90	90	90	90	
Temperature return oil Gen. End	44	44	45	45	45	45	45	45	
" " " Middle	58	58	59	60	60	60	60	60	
" " " Eng. End	39	39	39	40	40	40	40	40	
" Oil Supply	49	49	49	49	49	49	49	49	
" Engine Room	72	72	74	74	74	74	74	74	
" Air in Gen.	14	16	24	30	34	36	36	36	
" Air out Gen.	74	74	76	78	78	78	78	78	
" Ex. Steam	74	82	72	66	66	66	70	72	
" Cooling Water inlet	33	33	33	33	33	33	33	33	
" " " outlet	51	52	52	46	46	46	48	48	
No. Valves Operating	4	5	4	3	3	3	3	3	
Kilowatts	7600	8000	6800	5000	4600	5000	5600	5200	
Volts	103	108	108	108	108	108	108	108	
Amperes	660	670	570	440	400	440	460	450	
Field Excitation Volts	92	92	90	90	90	90	90	90	
Field Excitation Amperes	270	270	260	210	200	200	200	205	
Power-Factor	93	99	99	98	98	98	98	98	
Speed	1500	1500	1500	1500	1500	1500	1500	1500	

INSPECTION

Condenser and Pump	Main Governor	Steam Seal	Oil Pumps	Bafflers	Strainers	Oil Filters
OK	OK	OK	OK	OK	OK	

Oil Filters	Wheel Clearance	Brushes	Generator	Collector Rings	Emergency Governor	Cleanliness
OK	OK	OK	OK	OK	OK	OK

REMARKS:

Form 880

The Denver Tramway Company

Date Nov 27th 1918

Daily Report of Steam Turbine No. 8, Rating 7500 K.W.

Report by Albert Switzer Unit Started 5^{10} A.M. Shut Down 12^{55} A.M.

LOAD READINGS

TIME P.M.	3 lbs	4 lbs	5 lbs	6 lbs	7 lbs	8 lbs	9 lbs	10 lbs	
Pressure of Steam	170	175	180	175	175	175	180	172	
Pressure Degree Superheat	93°	103°	91°	103°	98°	93°	91°	85°	
" 1st Stage	38 lbs	50 lbs	60 lbs	55 lbs	40 lbs	30 lbs	20 lbs	22 lbs	
" Absolute Vacuum	.8	1.1	1.3	1.2	.9	.7	.6	.5	
" Barometer									
" Pump	90 lbs	90 lbs	90 lbs	90 lbs	90 lbs	90 lbs	90 lbs	90 lbs	
" Bearings	26 "	26 "	25 "	26 "	26 "	26 "	25 "	26 "	
" Hydraulic Gear	90 "	90 "	90 "	90 "	90 "	90 "	90 "	90 "	
Temperature return oil Gen. End	45°	46°	44°	45°	46°	46°	46°	46°	
" " " Middle	60°	60°	59°	59°	60°	60°	60°	60°	
" Gov. Eng. End	41°	41°	40°	41°	42°	41°	40°	40°	
" Oil Supply	46°	47°	46°	46°	47°	46°	46°	46°	
" Engine Room	72°	74°	76°	76°	76°	76°	76°	74°	
" Air in Gen.	30°	26°	24°	24°	24°	24°	22°	22°	
" Air out Gen.	76°	78°	80°	80°	80°	78°	76°	76°	
" Ex. Steam	74°	82°	86°	84°	74°	68°	62°	64°	
" Cooling Water inlet	35°	35°	34°	34°	34°	34°	34°	34°	
" " " outlet	50°	53°	56°	55°	52°	48°	46°	46°	
No. Valves Operating	4	5	6	5&6	4	3	2	2	
Kilowatts	5000	6000	7000	8000	5000	5000	5000	3000	
Volts	108	108	108	108	108	108	108	108	
Amperes	420	500	580	640	420	420	420	260	
Field Excitation Volts	88	90	90	92	88	86	84	88	
Field Excitation Amperes	220	240	250	270	220	220	220	180	
Power-Factor	985	99	99	99	99	985	985	985	
Speed	1580	1800	1500	1500	1500	1500	1500	1500	

INSPECTION

Condenser and Pump	Main Governor	Steam Seal	Oil Pumps	Bafflers	Strainers	Oil Filters
OK	OK	OK	OK	OK	OK	

Oil Filters	Wheel Clearance	Brushes	Generator	Collector Rings	Emergency Governor	Cleanliness
OK	OK	OK	OK	OK	OK	OK

REMARKS:

Form 1015

The Denver Tramway Company

WATT-HOUR METER READINGS

PLATTE STREET POWER HOUSE REPORT

Date Wed. Nov. 27th 18

Time	A.C. Unit No. 8 Meter K = 1000		A.C. Unit No. 7 Meter K =		A.C. Unit No. 6 Meter K =		A.C. Unit No. 5 Meter K =		A.C. Total Nos. 6, 7 & 8 Meter K =		A.C. To Converter Meter K = 100		Argo Meter K = 100		Broadway Meter K = 100	
P.M.	Readings	K.W.H.	Readings	K.W.H.	Readings	K.W.H.	Readings	K.W.H.	Readings	K.W.H.	Readings	K.W.H.	Readings	K.W.H.	Readings	K.W.H.
3	70500										97100		9200		6500	
4.	77000	6500									99500	2400	0100	900	7700	1200
5	84000	7000									02400	2900	1100	1000	9000	1300
6	92000	8000									05600	3200	2200	1100	0500	1500
7	98000	6000									08200	2600	3100	900	2000	1500
8	03000	5000									10200	2000	3800	700	3000	1000
9	08000	5000									12500	2300	4600	800	3900	900
10	12000	4000									14600	2100			4600	700

Time	Colfax Meter K =		Clear Creek Meter K =		D.C. Total Gen. & Con. Meter K =		D.C. Unit No. 4 Meter K =		D.C. From Converter Meter K = 1.6		D.C. Power & Lights Meter K = 100		Platte Street Transformer Temperatures			
P.M.	Readings	K.W.H.	Readings	K.W.H.	Readings	K.W.H.	Readings	K.W.H.	Readings	K.W.H.	Readings	K.W.H.	Bank No. 6	Bank No. 7	Unit No. 5	Rotary No. 3
3	9400		30000						90400		5850		25	25		27
4	0100	700	0500	500					91900	2400	5900	50	25	25		28
5	1000	900	1000	500					93600	2720	6000	100	28	25		32
6	2000	1000	1500	500					95400	2880	6100	100	30	30		36
7	2900	900	2000	500					96900	2400	6150	50	32	34		36
8	3500	600	2300	300					98100	1920	6175	25	30	30		32
9	4000	500	2600	300					99500	2240	6200	25		25		30
10	4500	500	2800	200					00700	1920	6250	50		25		28

Operator ____________ Operator ____________

FIG. 4. VARIOUS RECORD FORMS USED IN THE POWER PLANT

The coal used is a Colorado lignite with a heat value of about 9500 B.t.u. per pound as fired. The load on the power plant is purely a street-railway load, of familiar characteristic form. The guarantees for the large turbine and condenser and some tests on the boilers made it probable that it would be possible to produce a kilowatt-hour with 3.1 lb. of coal, as an average for a month, and this was adopted as the standard of fuel efficiency upon which to reckon the savings. If the large turbine is out of order and it is necessary to fall back on the auxiliary equipment, 4 lb. per kilowatt-hour is used as a standard. Fig. 5 shows a graphic illustration of the bonus scale.

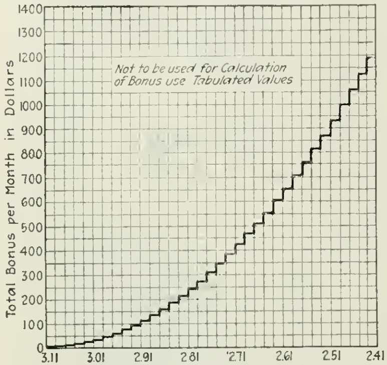


FIG. 5. THE BONUS CHART

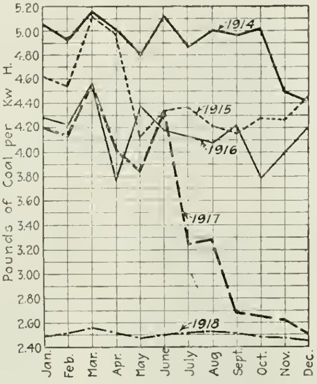


FIG. 6. COAL-CONSUMPTION CURVES

Many Checking and Economy Devices Installed

The possibility of earning a substantial bonus every month caused every man to consider the losses and how to reduce them. The activity in the boiler room, for instance, was concentrated on stopping air leaks on boiler and economizer settings, while the engine-room force made it a point to use the proper combinations of generating equipment in service. The logsheet, Fig. 3, and other record forms, Fig. 4, indicate some of the checking devices installed to assist in the campaign to cut down the coal consumption per kilowatt-hour. In addition recording economy draft gages, thermometers, steam-flow meters and CO_2 recorders are in use. The CO_2 recorder is used as a portable checking device and in connection with the portable draft gage gives the desired information concerning the condition of the boiler setting, fire, etc. Flue-gas temperatures are taken at intervals. In the boilers the original Stirling arches have been replaced with flat arches both for reasons of increased economy of operation and because it was believed the flat arch would stand up better and longer. The flat arches have proved to be superior in both ways.

The result is that the new turbo-generator takes care of all demands and the balance of the generating equipment is held in reserve. Three 750-hp. Stirling boilers take care of the steam demands. Eleven 415-hp. Stirling boilers together with their equipment such as stokers, economizers, etc., have been removed and sold at a good price. Two more boilers of the same size, with economizers and chain grates and some extra chain grates, are for sale now, and as all this equipment is still in first-class condition, there is no doubt that it also will bring a good price.

The results obtained can probably be best illustrated by the attached chart, Fig. 6, showing the coal consumption per kilowatt-hour at the present time to be approximately 2.5 lb., in November actually reduced to 2.47 lb., which represents a saving in operating cost of approximately $150,000 per year. These results are due partly to the better economy of the large turbine and partly to some other less costly improvements in the boiler room, but in no small degree to the introduction of the bonus plan.

A few words concerning the adopted bonus system may be of interest. The coal consumption per kilowatt-hour is figured for the gross output of the station and includes all power used for the plant, amounting to 1.25 per cent. of the gross output. If the coal consumption for net kilowatt-hours is desired, the correction should be made.

One of the principles used in working up the scheme was so to arrange the bonus scale that the benefits derived from the special efforts of the employees would be satisfactorily shared between the men and the company, and it was also considered better and simpler to pay each man the same amount. This has amounted to about $35 per man per month above the regular salary. No special competition has been fomented between watches, but as the amount of bonus each will receive at the end of the month depends upon the combined efforts of all, no man is permitted by his companions to "lie down on the job." The daily logsheet, together with the coal book kept by the boiler-room foreman, gives the men all the necessary information so that they can tell where they stand to date on the bonus.

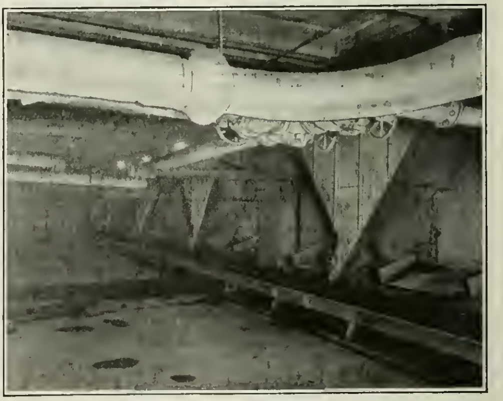


FIG. 7. ASH HOPPERS AND ASH CONVEYOR

It has been found that the wording of the bonus-system order offers sufficient restraint to prevent the employees becoming overzealous in their efforts, at the expense of the equipment. Thus, in accordance with the order, if No. 8 turbine has to be taken out of service for repairs, owing to faulty operation, no bonus is paid that month, and if damage is caused to the power house or any equipment through the fault of an employee, he is not entitled to participation in the bonus.

The bonus plan has now been in operation for a little over one year and no difficulties have arisen. This is probably due to the fact that the whole matter was placed before the men and discussed at meetings prior to the inauguration of the plan, as it was considered very necessary that each man should understand fully the method of calculating his share. One point of interest is that our experience at Denver indicates that it is not good practice to pay the bonus on the regular payday, for in spite of preaching and teaching some of the men form an idea that the bonus is simply wages and not an extra premium for increased efficiency. This point, as a matter of fact, reveals one of the danger marks of the whole bonus system.

Owing to the improvements made in the plant, an operating crew of only 25 men is now required, as compared with 55 men formerly. Shifts are now eight hours instead of twelve, and two weeks' vacation with pay is granted every man each year. Without doubt the incentive offered by a bonus has increased the economies, and it has also produced among the operating force a solidarity and coöperation which have improved the quality of power service. Cleanliness at the plant is considered a necessity. Inspection of all parts of the station is made with the greatest care, it being fully understood by the men that laxness may result not only in a pecuniary loss, but also in a loss in reputation reflected readily in a decreased amount of bonus earned.

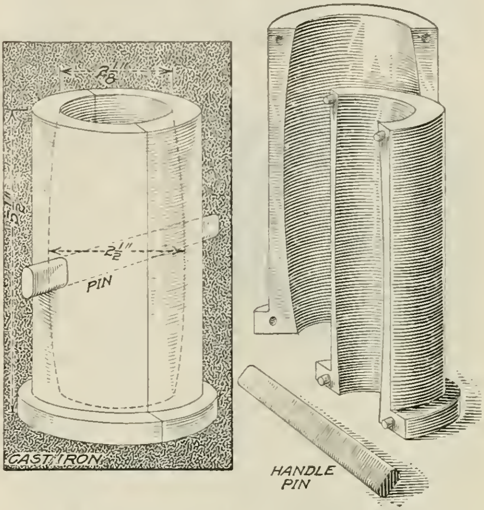
A great deal has been said in the past for and against bonus systems in general, and it is clearly understood that the same system is not suitable for every plant. In this case, however, the scheme adopted has worked out exceptionally well not only for both employees and employers, but also for the public in general, through a better utilization of coal and other materials and an increased reliability in the power supply.

Mold for Lead Hammer

Repairmen employed in large power plants find that babbitt hammers are useful because they do not batter the parts that are to be removed from or driven onto shafts, studs, etc. Naturally, a babbitt hammer does not last long, and it is the practice of some chief engineers to make their own.

In one plant new hammers are made by casting them in a cast-iron mold, which forms a hammer weighing 7½ lb. Its construction is shown in the illustration. It is split in two sections, the inner surfaces of which are turned out in a lathe to the shape of the exterior surface of the hammer, which is 2¼ in. diameter at the end; 2½ in. diameter at the center and 5½ in. long. The bottom of the mold is made with a flange so that it will stand on end while pouring the metal in at the top.

The halves of the mold are held together by means of a tapered oval wedge, shaped the same as the handle to be used, the wedge coming so as to form the handle hole in the center of the hammer. At the top and bottom of one half of the mold four holes are drilled and four corresponding pins are driven into the other half. These dowel pins assist in keeping the two parts of the mold in place.



MOLD FOR CASTING LEAD HAMMERS

When ready to pour a hammer, the babbitt is heated to a temperatre sufficient to char a stick, and after cleaning the inside of the mold it is assembled and placed on a piece of sheet asbestos with a little putty around the edges of the flange. The metal is then poured level with the top of the mold, and when cool the pin is knocked out, the halves of the mold separated, and after removing the hammer, the operation is repeated until the required number of hammers have been cast.

Delegates to the Convention, National Association of Stationary Engineers

Power will again this year try to publish the photos of attending delegates in its convention fun maker, the *Power Pup*. Also each delegate will be given a package of cards bearing his photograph, name, position, association and city. But to do this we must have either your photograph or the electrotype we gave you at previous conventions, together with name, position, association and city.

All photographs must be of post-card size and show only head and shoulders—the three for a quarter kind will do. All photos must reach us by Aug. 20. No photos will be accepted at Huntington, as Huntington affords no facilities for making electrotypes.

Please call this to the attention of your fellow-delegates and mail your photograph or electrotype today. These cards will help you to associate the names with the faces of the many new friends you will make. Address, Editor of Power, Tenth Avenue at Thirty-sixth Street, New York City.

Electric Temperature Indicator

By VICTOR H. TODD

THERE are a great many places where it is necessary to have a continuous indication of temperature, but the desirable spot may be very inaccessible for reading a thermometer, should one be installed For instance, in chimneys, hot liquids, hot gases, heating ovens, etc., it is possible to install thermometers, but it is inconvenient to read them. In other places, such as in coal piles, bales of material which are liable to take fire by spontaneous combustion, windings in generators, transformers, etc., it is desirable to know the temperature at any time (generally at periodic intervals), but it is practically impossible to install thermometers. Electric temperature indicators not only indicate the temperature continuously at any particular point, no matter how inaccessible it may be after installation, but they may be placed in any convenient location, for instance, on the engineer's desk or on a wall panel. Fig. 1 shows one type of temperature indicator; this particular instrument gives a continuous indication of temperature.

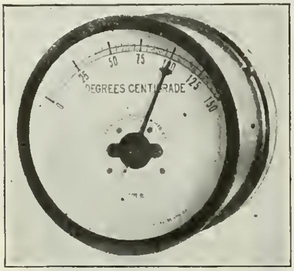


FIG. 1. TEMPERATURE INDICATOR

The temperature-indicator outfit consists of three main parts, which must be connected to a suitable source of direct current. They are the indicator, bridge arms (called the bridge box) and exploring coil. Advantage is taken of the well-known fact that the ohmic resistance of copper wire varies with the temperature. Consequently, if a coil of copper wire is embedded at the point where it is desirable to know the temperature, it is only necessary to provide means of measuring the resistance of the coil, and from this the temperature is determined. In actual practice it is not at all necessary to know the resistance in ohms of the coil, but since it is known that a given temperature produces a certain deflection on the indicator, due to a change in resistance, it is only necessary to mark this point as so many "degrees" of temperature and not so many ohms.

The apparatus is connected as shown in Fig. 2. The exploring coil is embedded at the desired point and connected with ordinary insulated copper wires to the bridge arms, *A*, *B* and *C*. These bridge arms are wound of resistance wire which has a negligible temperature coefficient (that is, its resistance does not change with varying temperature) upon insulated spools and inserted in a convenient housing, as shown in Fig. 3, which is called the "bridge box." Each resistor is carefully adjusted so that it is exactly equal to the resistance of the exploring coil at the point at which it must be most accurate. For instance, if an indication is desired from 30 to 130 deg. C. and 100 deg. C. is the most important point, then the resistance of the exploring coil would be determined at 100 deg. C., and each of the bridge arms *A*, *B* and *C*, Fig. 2, would be adjusted to exactly this amount.

In this case the pointer is mechanically set, by the spring or zero adjuster, to indicate normal temperature 100 deg. C., without current. Then a low-resistance (cold) exploring coil produces deflection to the left; equal resistance produces no deflection, so the indicator points to 100 deg. C.; and a high-resistance (hot) exploring coil produces a deflection to the right-hand side.

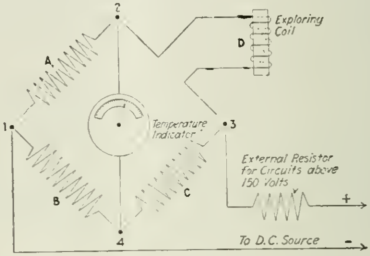


FIG. 2. DIAGRAM OF TEMPERATURE-INDICATOR CIRCUITS

The source of potential must be direct current and may be a constant-potential circuit of anywhere from 6 to 750 volts. Above 150 volts, however, it is necessary to provide another external resistor to limit the current. The supply leads are connected to points 1 and 3. The indicator is a high-grade direct-current voltmeter of the permanent-magnet moving-coil type. For ordinary applications the needle must deflect clear across the scale on 0.005 ampere. The indicator is connected to points 2 and 4 on the bridge box.

The exploring coil used for moderate temperatures is simply a strip of mica wound with a large number of turns of fine, insulated copper wire. This fine wire is welded to heavy leads which are mechanically anchored to the strip, and then, after a careful adjustment of resistance at a known temperature, the whole coil is impregnated in some heat-resisting compound.

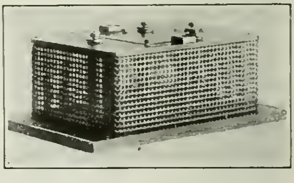


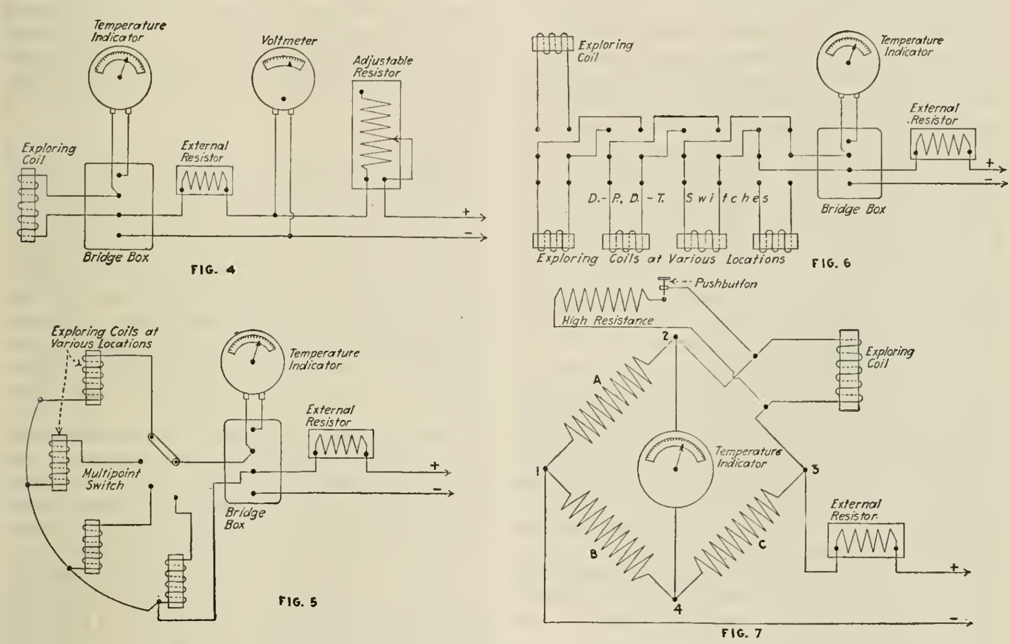
FIG. 3. BRIDGE BOX

For higher temperatures or for use in hot acids or gases which might destroy an unprotected coil, the exploring coil is wound, adjusted and sealed in a glass bulb from which the air has been exhausted in much the same manner as from an electric lamp.

The exploring coil or bulb is embedded at the point at which a temperature indication is desired and, as stated before, is connected by ordinary insulated copper wire to the bridge box and indicator. If the run is unusually long, a slight compensation must be made for the resistance of the connecting wires.

After adjusting the resistance of the exploring coil and bridge arms, the final calibration or checking is made experimentally by connecting all the apparatus properly and inserting the exploring coil in a hot oil bath and measuring the temperature with an accurate thermometer. The oil should be stirred constantly while heating, and sufficient time must be allowed for the coil to reach a uniform temperature before checking a result.

In many cases it is difficult to remove an exploring coil for a test, but accurate constants can generally be obtained from the manufacturers which enable the indicator to be checked by substituting a variable resistance or ohm box for the exploring coil. If the coil measures, say, 23.5 ohms at 30 deg. C., then when the ohm box is connected in instead of the exploring coil and plugged to 23.5 ohms, the indicator should indicate 30 deg. In a similar manner, by plugging in resistance equal to that of the exploring coil at various temperatures, it is possible to indicate the corresponding points on the indicator.



FIGS. 4 TO 7. DIFFERENT METHODS OF APPLYING THE TEMPERATURE INDICATOR

At the point of balance a change in the control voltage cannot affect the reading, but when the pointer is nearing the ends of the scale, a change in control voltage will change the temperature indication. The tendency of low-control voltage is to indicate high temperatures below the balance point and low temperatures above this point, while high-control voltage tends to produce low readings below balance and high readings above balance.

If these readings are very important, it may be necessary to install an ordinary voltmeter to indicate the control voltage, and if this varies considerably, to install an adjustable slide resistor to take care of control voltage fluctuations when reading the instrument. As shown in Fig. 4 this resistance is inserted so that the voltage may be adjusted on both the temperature indicator and voltmeter.

Any number of exploring coils may be used to indicate on one indicator if provided with proper switching arrangements. Of course the exploring coils must be identical in adjustment to give correct results, but they may be situated at various places, widely separated if desired, and indicate the temperature of various points in rapid succession. Sometimes a multipoint switch is used, as shown in Fig. 5. Another method, which utilizes standard double-pole switches, is given in Fig. 6. To start a set of readings, all the switches are thrown down and then each one thrown up as a reading is taken. Care must be exercised that perfect contact is made on the switches, as a poor contact may introduce sufficient resistance to cause a wrong indication.

When near the balance or normal point it is hard to tell if the outfit is working properly or not, as the pointer will indicate balance even though there should be no control voltage. To insure against this, it is customary to install a test button, as shown in Fig. 7. This button is in series with a resistance of several hundred ohms, and when it is pressed, it places this resistance in parallel with the exploring coil. This has the effect of lowering the resistance of the exploring-coil circuit, and consequently if the outfit is working properly, the pointer will indicate about 10 per cent. lower while the button is being pressed. If there is no control voltage on, there will be no change in deflection, thus denoting that the instrument is not functioning properly.

By substituting a sensitive relay-type of graphic meter for the usual indicator, it is possible to get accurate records of temperature behavior over any period of time.

Instead of a graphic, a sensitive polarized relay may be used to give a signal or close an electric circuit upon high or low temperature, thereby putting in operation any kind of electrically controlled apparatus such as blowers or pumps.

Opportunities for the Trained Engineer

By L. W. ALWYN-SCHMIDT

"CHIEF, I am through with this job! I'm done with power-house work! I'm going to be a mechanic or something else that pays better. Why, even a riveter can make ten dollars a day."

Jim, the assistant engineer, was the speaker. He had come to the plant as the successor of a young man that had left to take a chief engineer's position, and though he was willing, diligent and intelligent, he was dissatisfied. The world seemed to hold so many positions more desirable than that of assistant engineer.

The chief looked him squarely in the eye for a long moment.

"What's the matter, Jim?" he asked. "Haven't I been treating you right? Aren't your wages fair?"

"It's not you, chief. You've treated me square, and the pay is all I can expect. But I'm tired of being an assistant all my life. I want to get on. I want ——"

The chief interrupted him with a raised hand.

"Just a minute, Jim. So that's the secret. You want to get ahead, eh? Well, I've got something to say to you, and you may as well sit down while I say it. You're 28 and not satisfied. You want to climb. To do that, you've got to deliver the goods. Now, what have you done so far? What do you know? Do you read? Do you study? Are you at this moment able to hold a bigger job?"

Jim fidgeted, but he made no reply.

"No, my boy," continued the chief, still in his kindly tone, "you know you are not prepared to go ahead. That's why you would throw up the sponge and try something different. Don't make that mistake. This engineer life is a fine one, and if you know your business you can make something out of it. Don't get the idea that all the good jobs will dry up. Remember what I say—in five years there will be ten jobs for power-plant engineers where now there are three, and young men will be in demand. But these men will be of a different type from us. They will be better taught and better paid. Don't throw away a good chance. Stick to your job!

"There are many like you just now—young men who might do well as chiefs and who have all the advantages of learning offered to them. But how many really succeed? They are lured away from their jobs by the attraction of higher wages. When the new jobs end they drift back again to the power houses, but find that they have forgotten much and that they are not so suitable for assistants as they once were. They are much less eligible for positions as chiefs. Many of them may find a footing in other fields, but most of them become permanently uprooted, and the good material that, if properly directed, would have made a first-class chief may be wasted in minor employments. It is very little satisfaction to get years of experience running a 500-hp. steam engine and end one's life tending an apartment-house furnace.

"During the year 1910, the last year when an occupational census was made in the United States, 135,000 electrical engineers, 230,000 stationary engineers, 111,000 firemen, 96,000 locomotive engineers and 76,000 locomotive firemen were counted. The number of engineers on American ships is not recorded by the census. It is difficult to compare the result of the census of 1910 with that preceding it, but estimates made by the census officials show that the number of men finding employment in occupations related to that of the power-house engineer and including power-house engineers has grown approximately 50 per cent. No doubt the employment rate in power-house work has increased very rapidly during the last eight years following the census of 1910, and it is very likely that it has far exceeded 50 per cent. Allowing, however, for only a normal increase, this would mean that at the present time there are 200,000 jobs for electrical engineers, which of course are not all in power-house work proper, 345,000 jobs for stationary engineers and 170,000 for firemen.

"These figures are borne out by another method of estimating. Of the 200,000 stationary steam engines employed in the United States, 75 per cent. most likely are of such size as to require a chief and an assistant, while the remaining 25 per cent. require only one man to look after them. We have, then, 150,000 steam engines each with two attendants, which accounts for 300,000 positions, and 50,000 engines with one man only, accounting for another 50,000 positions, or 350,000 positions in all. This is just 5000 positions more than the figure estimated on the basis of the natural growth of the industrial occupations in the United States.

"Every new power unit added in national industries means an increase in the demand for power-house engineers. We cannot build hundreds of new ships without also making provision for manning their engine rooms. Every new machine built by the railroads represents a drain on the number of available engineers.

"Assuming that of the 200,000 electrical engineers only 50,000 are employed in power-house work, and adding these to the 345,000 men employed in connection with steam-power generation, the total national power-house force amounts to 395,000 men. Death, retirement from work, and other natural and economic causes will reduce this number at the rate of approximately 6 per cent. every year, so that approximately 24,000 men are required annually to fill the positions vacated by others. Approximately the same percentage of new men will be wanted annually to take the new jobs resulting from the expansion of the use of power for industrial purposes; thus, 48,000 power-plant jobs are open in this country every year for new men.

"The position of the power-house engineer has grown a good deal in responsibility. There is no room now for the easy-going men of former times. The war has taught us the wastefulness of having men of this type operating the primary sources of our industrial power. The power-house engineer of today must be a man well versed in his profession. He must be some thing of an accountant, an economist and a teacher. Only if he combines all these qualities with those of a first-class engineering training will he be able to fulfill all the duties required of him. How else can he trace the effectiveness of the power supplied by him from the power house to the machines? How can he arrange for the best application of the machinery in his charge, and how can he train a staff of helpers both in the power house and outside it to assist him in making the best use of the equipment?

"True, there are not many men to fit that description. Those available are quickly picked up by the large and progressive firms. But also the salaries offered for positions of this character are often not attractive enough to bring first-class men to the profession of power-house engineer. In time this condition will rectify itself. Factory owners will learn that a high-grade man, although probably costing more in the first instance, will in the end be less costly than a man commanding a smaller salary but deficient in knowledge. The one by his management will save more to the firm than he receives in additional salary; the other will cost too much, however cheap his price may be. The position is one which must be attacked from both ends. There must be an improvement in class and knowledge on the side of the engineer and a desire on the side of factory owners to employ men of better training. With coal prices where they are and where they will continue to be for quite a while, owners really cannot afford to employ any but the best-trained men.

"Men like you today have no excuse if they do not reach the higher positions, for there is plenty of room at the top. Education must be the ladder, and there is ample opportunity for obtaining education in this country. The engineer who finds time and leisure to visit the technical universities can get the teaching and the advice of the best engineers of the world. The man whose job holds him during the day finds free education in evening schools and public lectures. The man who cannot get away from his work at all, or whose circumstances will not allow him to attend school or lectures, has the assistance of correspondence schools and of many technical books written especially for the home student.

"The call for better education appeals not only to the young men but also to those who have been in service for many years. The war has shown the older men that they are more useful than they probably thought themselves. They have taken their stand in the second line and they have helped to fight the national battle as strongly and successfully as the youngest members of the engineering profession. No wonder that they are reluctant to relinquish the control they assumed while the young men were away.

"Unfortunately, not all of these older men had the training required for their work. When they were called to take leading positions they found they had to learn much that they thought was negligible. They have started to learn, and their new knowledge has been acquired while they adjusted themselves to the jobs. The work that has been done in this respect by the different agencies of the Fuel Administration no doubt will bear its fruit. It has shown the men the importance of their position and has added a new interest to their life. It also has provided a good deal of instruction, which should not be lost with the ending of the war. The engineering bulletins issued by the United States Fuel Administration will make useful reading for many years to come. They form an engineering library of enormous value to all who have to do with power-house work, and the different publications can be had at a price which hardly pays for a lunch.

"The war has brought the question of efficient power generating before the public eye, and the necessity of making savings has found more than usual discussion. The problems involved, however, are not connected with the war alone. They are in fact of considerably more importance during peace times, when the cost of producing energy becomes a matter of competition. The country that is able to produce industrial energy at the lowest cost will have a great advantage over the others. The question of whether our country shall stay in possession of its present export market and be able to increase it will be answered by the use we make of our large machine equipment. Ours is a country of high wages, and we are proud that our wage earners are better paid, lead healthier lives and are more prosperous than those in other countries. Nobody seriously wishes to change this; in fact, the tendency rather is to improve upon the present. So the machine equipment will have to help to remove the handicap of high wages in international competition. Human energy will have to be aided by machine energy. We shall want all the backing that our power houses can give us. They will be the basis on which we shall have to erect a structure of industrial and economic life.

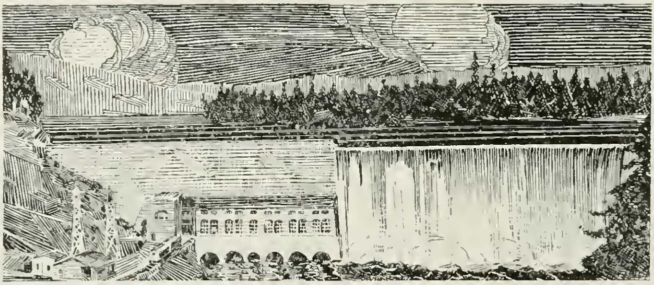
"That, Jim," concluded the chief, "is how I am picturing the future. The nation can use only big men to do this big job for her and chaps like you must not stand in the way. There are thousands of assistants ready to take jobs, and all of them, I am sure, will do their duty as conscientiously and as cleverly as you have done. But we do not want men who must be directed at every step. We need fully grown men—men who will keep that big plant out there doing the best that it can do. Jim, I want you to stay and be one of those men."

Jim stood quiet, his head bent. For a while the old dissatisfied expression clouded his face. Then it vanished, and he said: "I'll do it, chief!"

Difference in Boiler Prices

In reply to an inquiry sent out to boiler manufacturers for prices on a 72-in. x 18-ft. return-tubular boiler, 125 lb. steam pressure and per A. S. M. E. Code rules, the following prices were submitted by 26 concerns:

Key	Price Boiler	Gage Tubes	Price Fittings	Price Stack	Overhead, Per Cent.	Total
3	$1930.00	11	$622.40	$518.00	100	$3070.40
4	1975.00	11	739.42	627.00	180	3341.42
8	1908.00	11	506.00	408.00	.	2822.00
11	1936.96	11	733.81	473.27	175	3144.04
15	1904.20	11	619.80	597.90	150	3121.90
16	2219.68	11	328.47	347.66	150	2895.81
17	2100.00	11	583.00	386.00	150	3069.00
25	1788.77	11	456.98	382.54	175	2628.29
26	1847.77	11	494.19	426.60	180	2768.56
27	....	..	....	......	...	3745.00
29	....	..	...	......	150	2813.73
30	2320.00	..	125.00	391.00	175	2836.00
31	1603.82	11	612.32	406.00	100	2622.14
34	1826.36	11	577.75	388.86		2792.97
36	2570.00	..	200.00	575.00		3345.00
43	1803.35	11	377.32	375.34		2556.01
44	2078.14	11	485.82	506.30	.	3070.26
51	1919.31	11	675.05	553.26	100	3147.67
52	2076.90	11	288.65	248.00	180	2613.55
54	1725.44	11	376.03	197.04	160	2298.51
60	2454.08	11	398.35	406.54	150	3258.97
61	2138.00	11	643.50	313.85	60	3095.35
63	1982.37	11	389.61	415.59	175	2787.37
67	1879.20	11	463.28	Stack omitted	135	2342.48
68	1525.28	11	527.70	316.61	.	2369.59
73	1975.62	11	727.11	405.43	180	3108.16



POP'S WATER-POWER COURSE

By

John S. Carpenter

"JIMMY," exclaimed Pop, as he took a fresh chew and critically regarded the person addressed, "I guess our lectures are all off on account of the Board of Health's order agin the 'flu.' Public assemblages ain't allowed."

"Oh, Pop, don't say that. I don't see how any 'flu' germs could live in the same room with your and Jerry Geoghegan's pipes. And the rest of the fellows at the last lecture smoked such rank cigars that I feel pretty well sterilized and immunized."

"You're gittin' sorter finicky about your smokes lately since you got your raise," Pop allowed. "Better stick to old 'Sensation' and put the raise in War Savings Stamps. And while we're waitin' for them to lift the quarantine let's get down to our review. The subject," Pop announced with fitting gravity, "is how they find out what they got on a water-power site. The lecturer told us how the hydraulic engineer finds out how much water he's got to handle; how he checks the results by gittin' the average rainfall over as long a period as possible. Then he finds the area of the watershed or part of the country that drains into that river and multiplies that by the average rainfall, so finally he gits an idea of how much water he can figure per second after making allowances for leakage, evaporation, underground springs and a devil of a lot of other things. Agin the water he gits that way he compares the present flow of the river and makes allowances for flood and dry times, and the only way to git that is to find out from Si Perkins how high the water got when it washed away his chicken coops."

"What did he mean when he said they got the river flow by means of a weir?"

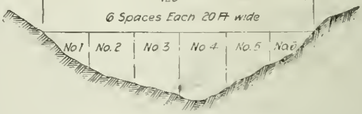
"A weir is nothin' but a board with a big enough notch cut in it so that water can all pass through the notch. That is, of course, when it's a small stream. For large streams they sometimes build weirs, but then it's almost a dam and it ain't easy. It's gen'ly easier to hunt a part of the river that runs pretty straight and then git the velocity by throwin' in floats and seein' how fast they travel per second. It's not as close as a weir, but if they do it right it won't be far off."

"He said something about current meters. How do they work?"

"Why, a current meter is only a fan wheel connected to clockwork that reads revolutions, and so many revolutions in so many seconds means that the water flows at a certain velocity at that point. Now, just to git the idea into my head I went up the creek Sunday afternoon and did the trick all by myself. I made three cross-sections of the creek, one down by the widder Jenks' farm, one at Casey's and the other at the sheriff's place. Here's what I mean by a cross-section." He showed Jimmy a sketch like that in the illustration. "You see, I measured off the creek into six parts of the same width and got the depths of each part. From that it was easy to find the area of each section. Then I used the current meter at a lot of different spots and I found that the water was movin' $2\frac{1}{2}$ ft. per second. That was the average of the ten readin's I took. So then I made up a table like this:

Number of section	1	2	3	4	5	6
Width of section, f.	20	20	20	20	20	20
Average depth, ft.	10	20	25	30	20	10
Area of section, sq.ft.	200	400	500	600	400	200

"You see, the area is just the width times the average depth. The area of the whole cross-section is



SECTION OF CREEK AT THE SHERIFF'S FARM

$200 + 400 + 500 + 600 + 400 + 200 = 2300$ sq.ft., and as the speed of the water is $2\frac{1}{2}$ ft. per second the stream flow must be $2300 \times 2\frac{1}{2} = 5750$ cu.ft. per second. Now then, I got the same kind of dope at all three places, and I compared the answers I got by multiplyin' the areas by the velocity in feet per second. They checked pretty fair."

"With a weir, Pop, I suppose it's generally accurate enough to make one weir and take one reading," Jimmy ventured.

"Gen'ly, unless it's for somethin' unusual. Now the Govamint has weirs in many parts of the country, what they calls gagin' stations, where they have a man stay and take readin's every day. Sometimes an engineer can git hold of somethin' like this and then his work is lot's easier."

"Do they have some kind of a wrist watch that tells how much water is going over the weir, or must it be figured out with a formula about the length of your arm?" asked Jimmy.

"They have a formuler, son, that neither of us could make head or tail of. I can't figger the three-halves power of a number and so I ast the lecturer if there was any tables and he said for us to write any of the waterwheel builders for their catalog and you'd find it in the back."

"Of course, Pop, I can see that all rivers don't flow the same all year around, and that's why it's so hard to get the true average flow. He said that there's such a thing as overdeveloping a river and that it must be nice to find out that there is'nt enough water to run all your turbines!"

"Now with findin' the head," Pop continued, "there ain't so much guessin'. They just send a surveyor up the line with one of them three-legged things they calls a 'wye level' and he can tell just what the difference in elevation is, which is the head. He told us, though, that the condition of the river affects the operatin' head, for when the river rises the water backs up and so reduces the head. And at low water the head is the most, when you need it the most, too."

"I suppose that after the water passes through one set of turbines they can use it in another, like running a bleeder turbine off another or from a set of engines," Jimmy hazarded.

Pop eyed the offender thoughtfully. "No, Jimmy, you can't. When they takes all the pep out of the water, so that it just about creeps away from the turbines, it's done for. It's got to fall some more before it can do any more work. I thought you knew better."

"Excuse me for living, Pop," exclaimed Jimmy, "and don't look at me like that. What I was most interested in at the last lecture was how they fixed the sizes of the units. If there is about 5000 hp. wanted on the river, supposing that there's enough water, he said the best plan is to install three units of 2500 hp. each because when there's flood times the head is reduced quite some on a low-head plant and then the units won't give 2500 hp. each. Then is when the third turbine comes in very handy and delivers the balance of the power. Some engineers, he said, would make such a plant into four units and fix the units so that three would handle the 5000 hp. and the fourth would be a spare. Against this is the cost of an additional wheel-setting and a larger power house, by dividing them up into four units."

"What he said about speeds is about the same as buyin' motors," said Pop. "He said that wise engineers always git the highest-speed turbine they can because they cost less, all things considered."

"But what was that about the efficiency being bad on the higher-speed wheels?"

"You heard wrong," Pop declared. "He said that engineers and builders too used to think that the higher the speed of the turbine the worse the efficiency was, too. But now they make such good turbines that the efficiency is about the same whether it's a low- or high-speed turbine. You forgot too, that the reason for keepin' the units large when you were talkin' about three units for the 5000-hp. plant instid of four is that the efficiency is better with large-sized turbines than with small."

"He got off a pretty good one about the man who thought he could get as much power as he wanted out of the river by just putting in more turbines, when the stream was doing all it could and there wasn't a drop of water going over the dam."

Pop smiled reminiscently. "Reminds me of a mill man who kept puttin' on more pumps and engines onto the old biler and used to give me Hail Columbia because I couldn't keep the pressure up. Nope, puttin' orders through the purchasin' department won't git you any more juice unless it's there to git in the river."

"How'd you like a job on that high-head plant on Lake Leman in Switzerland he spoke of, Pop? Think of it. They got two tiny turbines under 3000 ft. head; nearly 1300 lb. per square inch pressure, giving 1000 kw. with a mere dribble of water!"

Pop allowed that there were safer places to work than that. "On the other hand," he said, "at that low-head plant in France, where they've got some turbines workin' under 16 in. of head, I'd be ashamed to take my pay if I didn't stand on a chair and help throw water into the turbines with a pail."

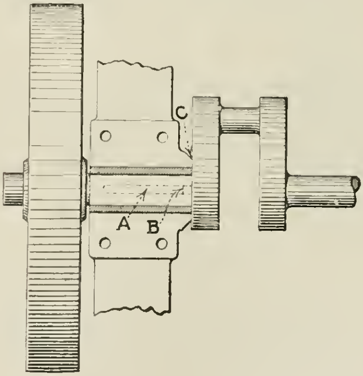
Just then the low-water whistle let loose on the south battery of boilers. Pop beat it in and frankly expressed his views to the ex-undertaker's assistant of a fireman. He emerged shortly with blood still in his eyes and resumed his chair. Jimmy busied himself with reading the announcement of the next lecture, while Pop gradually cooled down.

"Son," said the old man at length, "the next lecture's on the forebay, trash racks, log booms, penstocks and draft tube. We're goin' to strike the great divide then between the low-head and high-head plants. After we git through with turbines, the high-head work'll be next. So keep sober."

A Case of Oil Throwing

By P. A. Gett

A gas engine of the inclosed crank-case type developed a bad case of oil throwing from the flywheel, and I was called upon to correct the difficulty. An examination proved that the bearing had run hot enough to allow the babbitt lining to "wipe" over the oil grooves. There had been a groove in the bottom of the bearing, as shown at *A* in the illustration, and also a vertical groove in the end of the bearing at *B*, and the surplus oil supplied to the bearing had originally found its way back to the crank case through these grooves; but as both were now full of babbitt metal and the crank disk *C* rubbed the end of the bearing so closely that the oil could not get between, there was nothing it could do but run out at the other end of the bearing into the flywheel and from there to the four winds. Clearing the oilways corrected the difficulty.



OIL GROOVES WERE CLOSED

The Electrical Study Course—Alternating-Voltage Cycles

Explains how, if the maximum voltage in the cycle is known, the voltage at any other part of the cycle can be easily calculated; also, how to determine the number of cycles of an alternator when the number of poles and speeds are known.

IN TWO of the previous lessons it was indicated that when a single conductor, as in Fig. 1, or an armature, with a complete winding, Fig. 3, is revolved in a uniform magnetic field, at a uniform rate, an alternating voltage is generated which may be represented by the curves, Fig. 2. Such a curve is known as a sine curve, or wave of alternating voltage or current. In this lesson it will be shown how the voltage generated in a conductor or armature is proportional to the sine of the angle that the conductor or armature revolves through.

Assume in Fig. 4 that we have one body moving around the circle ABC at a uniform rate of motion and that a second body is moving across the diameter AC at such a rate as always to be in the same vertical plane with the body moving around the circle. That is, when the body moving around the circle is at a the body moving across the diameter is at a', or when the body moving in the circular path is at b the one moving across the diameter is at b'. From this it is evident that if the body traveling around the circle is moving at a uniform rate, the one moving across the diameter is moving at a constantly changing rate, being zero at A, increasing in speed until a maximum is reached at O and decreasing to zero again at C. At the instant that the two bodies are in the vertical plane BO, they are both moving at the same rate, therefore the maximum rate at which the body moves across the diameter is equal to the uniform rate the body moves around in the circular path.

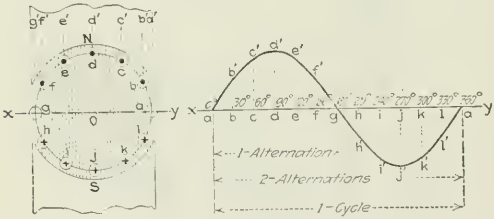


Fig. 1 Fig. 2

FIGS. 1 AND 2. CONDUCTOR IN A MAGNETIC FIELD AND VOLTAGE CURVE

What we have just seen in Fig. 4, regarding the rate of motion of the body moving across the diameter, is identical to the rate at which the conductor in Fig. 1 is cutting the lines of force. In Fig. 1, if we had a second conductor moving across the diameter xy at a rate that it would always be in the same vertical plane as the one moving in the circular path, they would both be cutting the lines of force at the same rate, being zero at a, increasing to a maximum in the vertical plane dO, and again decreasing to zero at g. Consequently the voltage (which varies with the rate of cutting the lines of force) generated in the conductor will vary from zero at a to a maximum at dO, and back to zero at g.

It has also been stated that if the radius of the circle above which the conductor revolves represents the maximum voltage, the vertical distance between the conductor and the diameter at any instant will represent the voltage generated in the conductor at this instant. Further consideration of Fig. 4 will show why this is so.

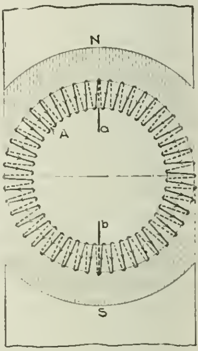


FIG. 3. ARMATURE IN MAGNETIC FIELD

In Fig. 5, which is the same as Fig. 4, consider the instant when the body moving in the circular path is at D. The direction of motion at any instant of a body moving in a circle is at a tangent to the circumference; that is, at right angles to the radius. Therefore, in Fig. 5, if we draw a line DF at right angles to the radius DO, it will represent the direction the body is moving in at this instant. On DF lay off DG equal to the radius of the circle which we have assumed to represent the rate at which the body is moving; then DG will also represent the rate at which the body is traveling around the circumference. Draw DH parallel to the diameter AC and let fall a perpendicular from G to DH, thus forming the right triangle DGH. Now, if DG represents the rate of motion of the body revolving around the circle, DH will represent the rate of motion of the body moving across the diameter at this instant; that is, if the body moving around the circle is traveling at a rate that will carry it from D to G in a given time, the body moving across the diameter will be moving at a rate that will carry it from D to H in the same period.

From inspection it is evident that triangles DGH and DOE are similar. This is also true from the fact that the sides of the two triangles are perpendicular to each other, that is DG is perpendicular to DO, DH to DE and FH to OE. We might use D as a pivot and turn triangle DGH on, and move it around to the left until DG coincided with DO. Then HD would fall upon DE and GH on OE. Then, since DH represents the rate of motion of the body moving across the diameter, DE and perpendicular distance between D and the diameter which is equal to DH will also represent the rate at which the body is moving across the diameter at this instant. In the last lesson we found that the sine of angle θ is equal to $\frac{DE}{DO}$, from which $DE = DO \sin \theta$. If we asume that the body moving in the circle is traveling at the rate of 15 ft. per sec., which is also the maximum rate across the diameter AC, and let the radius DO represent this rate, and at this instance let angle θ

be 30 deg.; then the rate at which the body is moving across the diameter is $DE = 15 \sin 30$ deg. Sin 30 deg., from the table given in last lesson, is found to be 0.500; therefore $DE = 15 \times 0.5000 = 7.5$ ft. per sec. This must not be confused with the distance traveled, as the body has moved only the distance AE, which in this case is about 2.1 ft., but in moving this distance the body has been accelerated to about 7.5 ft. per sec. At 60 deg., Fig. 6, $DE = OD \sin 60$ deg. $= 15 \times 0.866 = 12.99$ ft. per sec., and the body has moved the distance AE, or 7.5 ft. In each case the rate of the body moving along the diameter AC is proportional to the sine of the angle through which the body traveling around the circle has moved.

From the foregoing it is evident that a curve, representing the rate at which the body is moving across the diameter when the radius represents the maximum rate, may be constructed by laying off equal distances Ab, bc, *etc.*, on the line xy, Fig. 7, representing the divisions of the circular path, at these divisions erecting verticals and projecting from the divisions on the circle to intersect the verticals at b′, c′, etc. By joining the points thus obtained a curve representing the rate of motion of the body across the diameter will be the result. Since the vertical distances between the curve and the line xy is proportional to the sine of the angle that the body moving around the circle passes through, the curve is called a sine curve.

What we have just seen is that a body traveling around in a circle at a uniform rate has a rate of motion parallel with the diameter of the circle which is proportional to the sine of the angle through which it passes. Therefore, if a conductor is caused to travel in a circular path, as in Fig. 1, at a uniform rate, it will be cutting across the magnetic field at right angles to the lines of force at a rate proportional to the sine of the angle moved through, hence the voltage generated will be proportional to the sine of the angle. It is for this reason that the voltage or current wave obtained from a conductor revolving in a uniform magnetic field is called a sine curve. This is also true for the voltage generated by a number of conductors in series on an armature. In Figs. 8 and 9 of the lesson in the July 15 issue, the voltage was found to be 73.62 when the armature had revolved to 30 deg. from the zero position, 132.7 when the armature was at 60 deg. from the zero position and 153.32 at 90 deg., or at the position of maximum voltage. By multiplying the maximum voltage 153.32 by the sines of angles 30 and 60 deg., which are 0.5000 and 0.8660 respectively, we have $153.32 \times 0.5000 = 76.66$ and $153.32 \times 0.8660 = 132.7$; these correspond to the values obtained by the measurements methods in the previous lesson. Therefore in any armature generating a voltage that varies according to a sine curve, if the maximum voltage is known, the voltage generated at any other instant is equal to the maximum voltage times the sine of the angle the armature has revolved through, in electrical degrees, at the instant when the voltage is calculated.

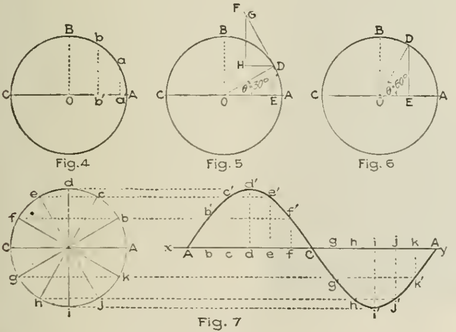


Fig.4 Fig.5 Fig.6

Fig. 7

FIGS. 4 TO 7. ILLUSTRATE THE CONSTRUCTION OF A SINE CURVE

The line xy, Fig. 2, may be considered as representing the degrees, as shown, since it represents the distance the conductor moves in generating one cycle. In Fig. 1 the conductor made a complete revolution for the voltage to pass through one cycle, but this is true only in a two-pole machine. If the machine had four poles, when the conductor passed two of them or made a half-revolution, the voltage would have passed through one cycle, consequently two cycles in a complete revolution. In other words, the voltage passes through a cycle each time the conductor passes a pair of poles. Then it is evident the cycles per revolution equal the number of poles, P, divided by 2; then the cycles per minute would equal the cycles per revolution times the revolutions per minute, S, or $\frac{P}{2} \times S$. The cycles of any alternating-current circuit is usually expressed as so many cycles per second and will equal the cycles per minute divided by 60. Thus, if we let f equal the frequency, the cycles per second, we have $f = \frac{P}{2} \times \frac{S}{60}$ or $f = \frac{PS}{120}$. This is the same as saying that the cycles per second (f) of any alternator-current generator are equal to the number of poles (P) times the number of revolutions per minute (S) divided by 120. The frequency of an alternating-current generator having four poles and running 1800 revolutions per minute will be $f = \frac{PS}{120} = \frac{4 \times 1800}{120} = 60$ cycles per second. Since a cycle equals two alternations, the voltage will be changing its direction $60 \times 2 = 120$ times per second.

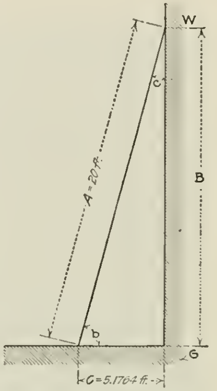


FIG. 8. DIAGRAM REPRESENTING LADDER AGAINST WALL

The problem of the preceding lesson was to find how high up a wall a 20-ft. ladder would reach if its foot were placed 5.1764 ft. away from the wall. Also to find the angle that the ladder makes with the ground and the one it makes with the wall. In Fig. 8 let A be the ladder, W the wall, and G the ground. A is given as being 20 ft. and C as 5.1764 ft. It is required to find B and the angles b and c. Since A, B and C form the sides of a right-angle triangle, we know that $A^2 = B^2 + C^2$ so that, by substituting the known values, we have $(20)^2 = B^2 + (5.1764)^2$. Squaring the quantities gives us, $400 = (B)^2 + 26.7951$, from which we get $(B)^2 = 400 - 26.7951 = 373.2049$ and $B = \sqrt{373.2049} =$

19.3185 ft. To determine the angles b and c we make use of the fact that sine $b = \frac{B}{A}$ and $\sin c = \frac{C}{A}$. Thus we have, $\sin b = \frac{19.3185}{20} = 0.9659$ and $\sin c = \frac{5.1764}{20} = 0.2588$. Looking up the angles corresponding to these values in the table published last week, we find that $0.9659 = \sin 75$ deg. and that $0.25882 = \sin 15$ deg. Consequently $b = 75$ deg and c 15 degrees.

Since sides A and C were known, we can find the sine of angle c first, which we have already found to be $\frac{C}{A} = \frac{5.1764}{20} = 0.2588$, equals sin 15 deg., that is angle c equals 15 deg. and angle b will equal $90 - 15 = 75$ deg. Then $B = A \sin b = 20 \times 0.9659 = 19.318$ ft., as obtained by the other method.

1. In Fig. 2, if the maximum voltage is 250, what will the instantaneous value of the voltage be at 25 and 65 deg. of the cycle?

2. An alternator has 16 poles and runs 187.5 revolutions per minute. Find the frequency in cycles per second, also the number of alternations per minute.

Crankshaft Successfully Welded

An example wherein welding has quickly and successfully restored to operation and added years of service to large crankshafts that have been broken by overloads is shown by the accompanying illustrations of a repair on one of two crankshafts at the South Norwalk Electric Works, South Norwalk, Conn.

During a heavy load season at the close of 1915 and the beginning of the year following, this company had the misfortune to have the mainshafts break in two of its largest engines within two months of each other—one in its largest steam engine and the other in one of the Diesel engines. The first break was discovered just as the yearly peak load was well under way. A new shaft could not be purchased as there were none like it on the market and the already overburdened manufacturers of such parts could not warrant reasonable delivery. The situation was especially serious because the company not only supplied a considerable lighting business but also furnished power for the operation of approximately one hundred important local industries, all of which were at their busiest period. It was finally decided to have the shaft Thermit welded. This was done and the crankshaft was soon returned as good as new.

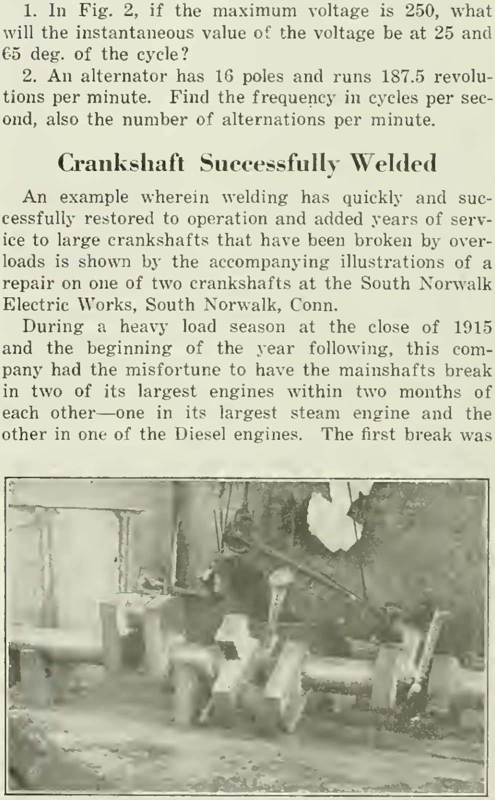


FIG. 1. TWO THERMIT WELDS ON A 9-IN. DIESEL-ENGINE CRANKSHAFT BEFORE RISERS AND POURING GATES WERE CUT OFF

To those who are unfamiliar with the Thermit process, it may be explained that Thermit is a mixture of aluminum and iron oxide. This mixture can be ignited by means of special ignition powder and on reaction produces superheated liquid steel and slag (aluminum oxide), at a temperature of approximately 5000 deg. F. This Thermit steel is sufficiently hot to melt and dissolve any metal with which it comes in contact and amalgamates with it to form a solid homogeneous mass when cool.

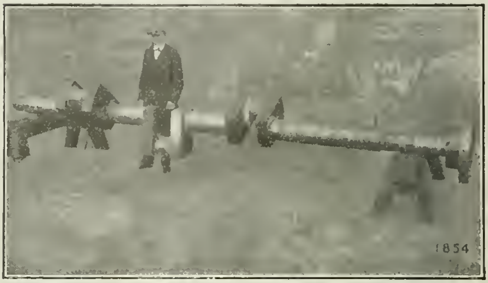


FIG. 2. CRANKSHAFT AFTER THE THERMIT WELDS HAD BEEN MACHINED

In making the crankshaft repair, the broken sections were lined up together so that a small gap was left between the broken ends. This gap was filled with yellow wax and a mold box built around the broken ends. Gasoline and compressed air preheating torches were then directed into the mold, serving the triple purpose of burning out the wax to provide space for the Thermit steel later to enter, preheating the parts adjacent to the weld sufficiently to permit a more uniform contraction on cooling, and drying out the mold. The Thermit steel generated by the reaction was then poured from an automatic crucible into the welding space and allowed to cool and the excess metal formed by pouring gates and risers cut off. The function of a riser is to hold a supply of liquid steel which will feed into the weld during shrinkage and thus fill up any pipes that may form in the weld. It also acts as a depository, allowing any foreign material to be washed out of the weld into the riser.

Later, one of the large Diesel engine shafts developed a fracture in the throw of one of its cranks, and upon further examination, it was found that another crank was also fractured. This shaft, shown in the illustrations, was welded in its two broken locations with excellent results.

The unavoidable distortions by reason of inequalities in heating and cooling were so small as to be readily remedied by truing up the shaft in the lathe with a simple light cut where needed. This work was done by the repair company, while it was only necessary for the operating company to babbitt the main boxes, scrape in the shaft and refit the crankpin boxes.

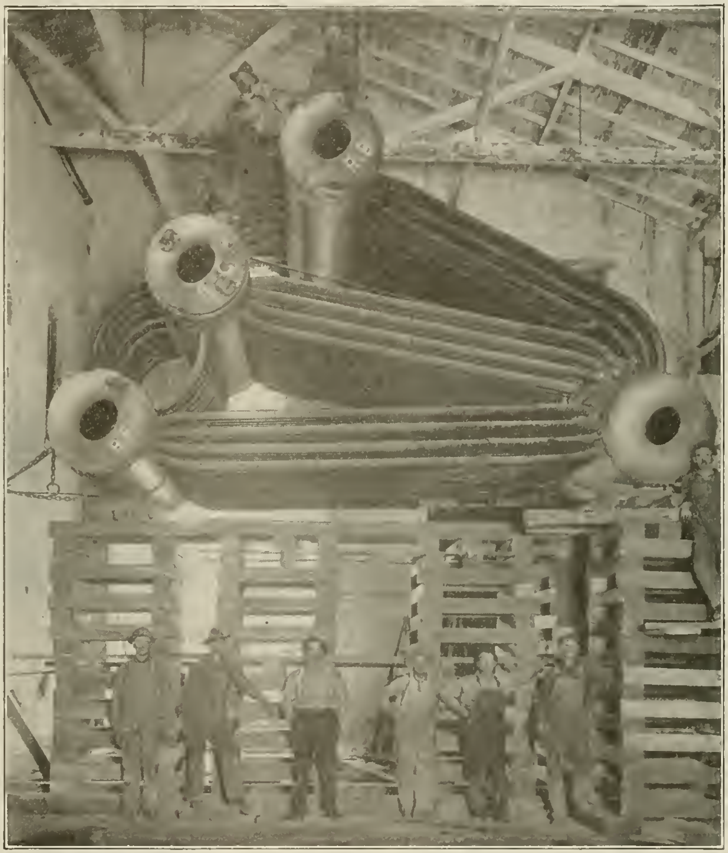
According to very recent reports from Albert E. Winchester, general superintendent of the company, the big steam engine stands ready with its other auxiliaries for immediate service, while the Diesel engine has been in faithful operation most of the time since its shaft was mended over three years ago.

Water-Tube Boilers Are Successfully Removed Intact

By Clifford A. Elliott*

After removing a steel smoke-stack by auto trucks from the Vineyard power plant of the Pacific Electric Railway Co. to the Torrance plant of the same company, occasion arose to move to Torrance two 250-hp. Stirling boilers that were no longer giving service at the Vineyard plant. It was first thought impossible to release each boiler complete, consisting of four 24-in. drums with its numerous 3-in. tubes. If the tubes connecting the four drums, as shown in the illustration, had been cut and again welded into place, it would have cost approximately four thousand dollars to remove the two boilers complete in this manner. The contractors who had successfully handled the removal and relocation of the steel smokestack were able to take the contract to handle the removal of the boilers intact, thus saving considerable time and expense.

The first steps taken consisted of releasing each boiler complete from its permanent position on a brick foundation, at which time the bolts were removed from steel frames set in brick enclosures, which frames supported the boilers and held them in place. The next step was to elevate the rear end of the boiler to the level of the front end; after which they would set up the first cribbing, move the boiler on rollers across the steam mains without touching these mains; thence over additional cribbing to a point opposite a door in the side of the concrete wall of the power plant, which was enlarged, a 4-ft. jamb 10½ ft. high being necessary, the jambs being taken out in two pieces. It will be observed from the illustration that as each unit of cribbing was set up, all units were tied together by longitudinal timbers set in the cribbing when and where necessary, so that in the event that the boiler should fall when being skidded via rollers over cribbing, it would carry all cribbing when falling. A donkey engine located on a flat car on a spur track opposite the plant carried a cable line in through a side-wall window for towing the boiler on rollers over planking placed on top of the cribbing. The maximum height of the cribbing units was 10½ ft. When the boiler was brought to a point opposite the door, it was lowered by sectional units of the cribbing being removed, then turned at right angles to the door and moved on rollers or skidded out of the building, where it was again moved on rollers up an improvised timber incline over an 8½-ft. retaining wall, from which it was moved upon a steel flat car for shipment to Torrance. It was transported to Torrance by special arranged service, as because of possible impaired clearances it was deemed inadvisable to transport it via regular freight-train movement. The approximate weight of each boiler complete was 47,000 lb.



STIRLING BOILER, 250 HP., BEING REMOVED INTACT

Four steel flat cars were required to handle the two boilers complete. One car was assigned to each boiler, the third car for valves, door fronts and miscellaneous other parts, and the fourth car for the breeching, donkey engine and hoisting equipment, cribbing and tool outfit of the contractors.

Allen Brothers, of Los Angeles, were the contractors who handled the removal and relocation of the boilers. The most important factor in this successful moving operation is the three-point suspension method of moving.

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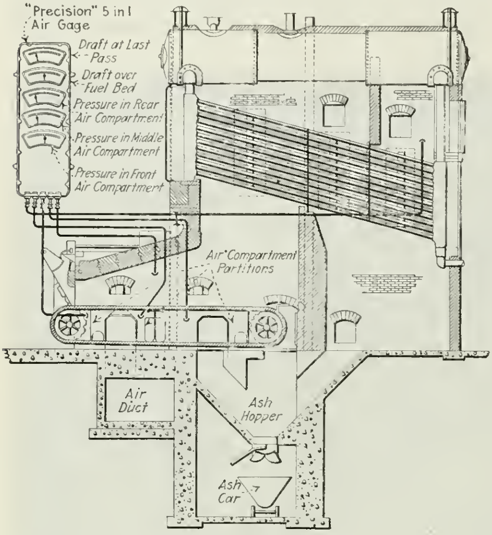
*Cost Engineer, Maintenance of Way Department, Pacific Electric Railway Co., Los Angeles, Calif.

Five-in-One Draft Gage

Draft losses in boilers depend upon the type of baffling and the condition of the fuel bed. High resistance may be caused by too thick a fuel bed, slag in the air spaces in the grate or air spaces too small for the coal used. Dirty flues and tubes also are a contributory cause. Draft may be reduced by doors being open in the uptake, chimney flues, or air ducts, etc. Generally, a boiler is equipped with some type of draft gage, but this does not tell the condition of the draft in various parts of the boiler settings.


"Precision" 5 in 1 Air Gage
Draft at Last Pass
Draft over Fuel Bed
Pressure in Rear Air Compartment
Pressure in Middle Air Compartment
Pressure in Front Air Compartment
Air Compartment Partitions
Air Duct
Ash Hopper
Ash Car

DRAFT GAGES AND CONNECTIONS

In order to permit the operator to know what the draft and air pressure are at every point, the Precision Instrument Co., Detroit, Mich., has developed the "Five-in-One" draft gage, which is connected to the boiler setting as shown in the illustration. The gage tells at a glance the pressure at the first, second and third air compartments, the draft over the fuel bed and the draft at the last pass. If a hole develops in the fuel bed, the gage shows it instantly by the needle on one of the three lower dials, dropping back toward zero and it not only tells of the existing hole but also where to look for it.

Referring to the top gage, which is connected to the draft at the last pass, the operator should keep the needle low so as to reduce the chimney-gas loss due to excess air. The needle of the second gage from the top registers the draft over the fuel bed and should be kept near zero on the draft side. If the needle gets on the pressure side, the burning gases will be deflected downward and upon the stoker parts and brickwork. The third gage indicates the draft at the rear compartment of the windbox, the next one the draft at the center of the windbox, and the bottom one the draft at the front compartment of the windbox. The operator should keep the needles of the three lower gages at points determined by experience or tests. If the fire side of the boiler is dirty, this cannot be done without forcing in air on the pressure side.

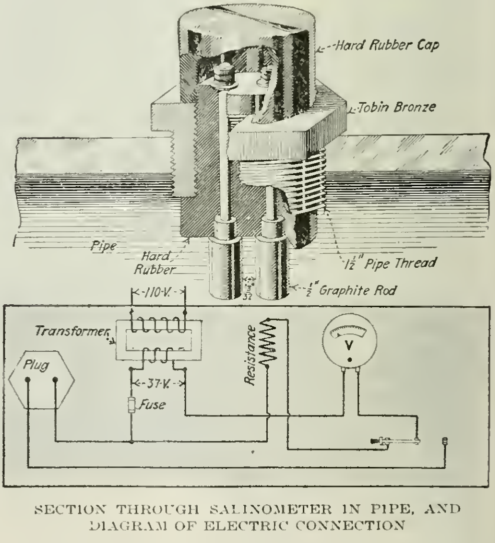
The standard readings for the stoker draft are 0 to 2 in. of water for the flue, 1 in. vacuum to 1 in. pressure for the combustion chamber, 0 to 6 in., 0 to 4 in. and 0 to 1½ in. for the front, center and rear air compartments, respectively.

Variations in pressure or vacuum are transmitted by the diaphragm through a vertical adjustable plunger attached to a horizontal shaft by means of a link or lever adjustable in length. At the side of the case are screw adjustments by which the operator may bring the pointer to zero when necessary. There are five main adjustments, which enable the movement to be calibrated to dead accuracy at every division. The gages are supplied in black enameled cast-iron cases and are dustproof.

Salinometer for Power-Plant Use

By H. S. Knowlton

The Chile Exploration Co. is using an electric salinometer, illustrated in the accompanying diagram, for testing boiler-feed water and checking the leakage of condenser tubes. The apparatus, which was built by Thoner & Martens, Boston, Mass., from original designs of the Edison Electric Illuminating Co., of Boston, consists mainly of a plug with two graphite electrodes, which is inserted in the feed-water piping, the carbons being mounted at the bottom of a hard-rubber block through which metal terminal rods are run to binding posts at the top, inclosed by a hard rubber cap. A transformer reducing the potential to 37 volts from the ordinary 110-volt service is provided with a voltmeter and resistance for comparing the drop across the salinometer terminals with previous calibrations.



SECTION THROUGH SALINOMETER IN PIPE, AND DIAGRAM OF ELECTRIC CONNECTION

Governor Smith of New York has approved a bill proposing elimination of adult illiteracy in state. The new law appropriates $100,000 for the Americanization plan outlined by the Board of Regents. There are about 600,000 persons in the state unable to speak English and about 350,000 unable to read or write any language.

EDITORIALS

The Price of Coal

SENATOR Frelinghuysen has introduced a resolution providing that, whereas the price of coal has continued to rise without any apparent economic or other proper reason therefor, the Committee on Interstate Commerce be instructed to make inquiry into the causes which have brought about the enormous increase in the market price of coal with a view to determining who or what may be responsible for such increase in price, and whether it is due to economic causes or to manipulation and profiteering; and with a view further to recommending either Congressional or Executive action in order to remedy the existing conditions and bring about the punishment of any individual or corporation deemed guilty of unlawful acts.

Power readers, the largest purchasers of coal, will be interested in the progress of this bill and of the investigation that it authorizes. The fuel supply is one of the first requisites in the industrial and domestic life of a people. It is unthinkable that its purveyance should continue to be left to the uncontrolled manipulation of those whose only interest is to make its handling yield the greatest amount of profit to themselves.

This bill interests others than the user of coal for manufacturing and power purposes. The price of coal bears upon everybody. It is a factor in the production, transportation or distribution of everything that one buys. Higher prices paid for coal furnish a legitimate reason for an increase in the price of everything else.

With the application to the eternal struggle against the forces of nature of accumulated knowledge and experience and scientific discovery; with the employment of the marvelous tools and machinery at our command; with facilities for handling, storing and distributing which have never been equaled; with uses found for a large portion of the product formerly thrown away; with all of the economies of aggregation which should result from doing things upon a big scale—why should the public be paying the present prices for the service of mining coal?

For it is for the service and not for the coal that the public is paying. The conception that a group of men could fasten upon a natural resource like coal and dole it out at a price imposed by the necessities of their fellow-man is too repugnant to modern ideas of the relation of the rights of property to the rights of man to be contended for. What the coal operator has a right to charge is the cost of the service that he renders in maintaining his mine in working condition and getting coal out of it, plus a fair profit on that cost. The cost of rendering that service ought to be demonstrable before such committee as Senator Frelinghuysen proposes. The profit, not the price, ought to be fixed. Everybody expects the operator to make a fair profit as the condition of continuing to operate, and is willing to pay such fair profit. It may be that such an investigation as this bill proposes would reveal the fact that the operators are making only a fair profit. If it did, it would relieve a very widespread sense of resentment and imposition, and the public would adjust itself to the carrying of the necessarily high prices with resignation if not with contentment. But if it should not, no sophistic cant about the rewards of initiative, thrift and industry, no overstrained consideration for property interests and the right of one to do as he pleases with his own should stand in the way of just reparation for advantage taken of the people in a time of national stress, nor of drastic measures to prevent the continuation of extortion and profiteering, which is no more than a wholesale type of usury and as logically subject to restraint and punishment.

The Length of Boiler Seams

ON PAGE 23 of *Power* of July 1 we invited discussion on the safe limit of length in the longitudinal seam of a boiler. We have received some comments, but we want more.

Massachusetts will not allow a continuous longitudinal joint over twelve feet in length—whether it be of the butt-strapped or the lap variety—upon a horizontal return-tubular, vertical-tubular or locomotive-type boiler.

The Boiler Code of the American Society of Mechanical Engineers simply forbids the use of a course over twelve feet in length on horizontal return-tubular boilers with lap joints. With a butt-strapped joint a course of any length may be used provided specimens cut from the sheet parallel with the circumferential seams meet the standards prescribed in the specifications of the Code for boiler-plate steel.

This is one of the main points of difference between the two codes, and it is difficult to see why there should be any difference in this particular.

Does a boiler require the stiffening effect of the roundabout seams?

Does it require this as much with a butt-strapped joint as with a lap joint?

Is the long joint dangerous only when the sheet comes in contact with the fire as in the horizontal return-tubular boiler, and is this the reason that vertical-tubular and locomotive-type boilers are exempted in one code? If they are dangerous in the unexposed shells of fire-tube boilers, why are they not equally so in the drums of water-tube boilers?

Why does Massachusetts limit the length upon the three types, horizontal, vertical and locomotive, and the A. S. M. E. Code only upon one, the horizontal?

Why does the A. S. M. E. Code allow an unlimited length of course with a butt-strapped joint and restrict it with a lap joint?

Our thought in inviting discussion upon this subject is that it is after all an engineering question which ought to be decided definitely and positively one way or another if the best knowledge and experience and thought of the designers, builders, inspectors and users of boilers were available. There is no doubt that the makers of the Massachusetts Rules and the A. S. M. E. Code want to be safe, but neither wants to be arbitrary or unnecessarily restrictive. When they both get the best that can be made, their codes will be alike and in that respect alone will be better for the man who manufactures the boiler as well as for the man who uses it.

Have you had any experience with boilers with long courses? Have you any ideas about them? What would you say about them if you were a member of the Massachusetts Board of Boiler Rules or of the A. S. M. E. Committee on Boiler Code and had to express an opinion? Which code is nearer right and why?

The Bonus System Successful at Denver Plant

IN MODERN power-plant management most engineers see in bonus systems a source of appreciable economies and labor contentment, yet to get these presents more obstacles than any other feature of management, operation and design. The human factor is always the most uncertain. Call together the heads of nearly every mill, factory or works and it will be agreed by all that bonus payment for the power-house men is highly desirable. But ask "How are we to apply it to our particular conditions?" The successful solution usually comes only after long consideration and many trials—all worth while. Those who have stuck to the problem and who have had many discouraging experiences are its strongest advocates. One never becomes so discouraged that he thinks there is not considerable to be gained by the application of the right system to his plant.

Readers likely remember that Dr. D. S. Jacobus, in his paper, "Methods of Increasing Boiler-Room Efficiency," an abstract of which was published in *Power* of July 15, referred to the bonus system as applied by Edward N. Trump, vice president of the Solvay Process Company. Mr. Trump's experience has made him an enthusiastic supporter of the bonus plan for power-plant men. He has made it work successfully in his great plant. Perhaps one of the most noteworthy examples of what a bonus system can do in a power plant is that of the Denver Gas and Electric Company, explained fully elsewhere in this issue.

This plant is, as its name implies, a central station; it is of average size and equipment. In the year that the bonus system now used has been applied, $150,000 has been saved on unit plant costs. The engineers have worked out a table giving the bonus to be paid for various coal consumptions per kilowatt-hour. This figure is now down to 2.47 pounds, and the total monthly bonus paid to the plant employees, who share alike, is $932. The shifts are now eight instead of twelve hours, and the number of employees has been cut from fifty-five to twenty-five. The men now get two weeks vacation with pay. The reduction in the number of men is in part because of more modern and larger equipment.

Bonuses at Denver are so arranged that the men share alike, so long as each has conformed to the bonus rules, which are given in the article and are worth the study of every engineer and manager. So far the bonus per man amounts to thirty-five dollars per month above the regular salary, ninety per cent. of which is paid monthly, though not on payday, the balance retained and paid semi-annually. Now when men have dropped into their hands as though out of the sky, such an amount, or amounts in proportion to saving effected, it becomes one of the most satisfactory kinds of welfare work employers can provide.

It should be noted that at Denver no special competition is fomented between watches. The amount each receives at the end of the month depends upon the combined efforts of all.

The Federation of Refrigerating Societies

THE foremost societies of the refrigerating industry have federated, forming a parent body known as the American Association of Ice and Refrigeration. It is composed of eleven, possibly more, organizations. The purpose of the consolidation is best set forth in the words of Frank A. Horne, president of the American Association of Refrigeration, who conceived the idea and is father of the movement. Mr. Horne said:

> During the reconstruction period there will be increasing necessity for joint activity and unified strength in confronting the problems of the future. It is evident to all that under the present arrangement there is much duplication of effort, loss of influence and power because of division, lack of breadth because of intensive specialization, loss of information by reason of separation, and waste of time and money in the separation of executive forces. This is no plea for a merger or a consolidation of forces, but for a better and more efficient federation of existing agencies and those that may be organized in the future.

The parent body, as this association will be called, is the medium of contact with international, national and state laws, organizations and functions. It will conduct statistical, educational, publicity and legislative development for the industry.

Certainly, refrigeration is one industry that needs the activity of such an organization. There is too much to be done to leave the work to be pursued in rather disjointed fashion. This organization will be to the refrigeration industry what the National Electric Light Association is to the electric public utilities. Rightly organized and guided, it can be made a clearing house for all essential information, technical, commercial and legal, relative to refrigeration, ice making and cold storage. Through it, with the influence it can be made to wield, the industry should be more successful than now in getting the governmental departments to assist in finding and serving the many data now needed by the engineers in the industry.

Reliability and economy are the real measures of the value of a power plant and its engineers. A poor plant with a good engineer is blessed; but a good plant in poor hands is doubly cursed.

Many a man who knows there is room at the top sits down and waits for the elevator.

Any kind of success worth having never arrives unexpectedly.

It is not knowledge but the application of it that is valuable.

Correspondence

Unreliable Safety Attachments

Just as the spring-loaded safety valve is the most dependable device for guarding against boiler explosions from overpressure, so is the automatic engine stop the best device for guarding against flywheel explosions from overspeed. The truth of this has been demonstrated time and again in the experience of engineers handling engines equipped with belt-driven governors.

An example of how little dependence can be placed on ordinary attachments for preventing inaction of the safety cams of a Corliss engine, in the event of the governor belt breaking, was found in a mill where the engine flywheels had been insured against accident.

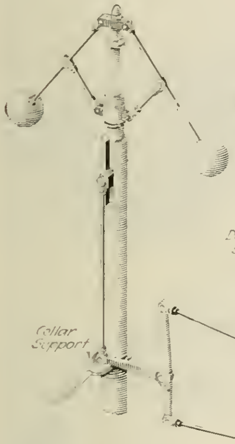


FIG. 1. DANGEROUS GOVERNOR-STOP COLLAR

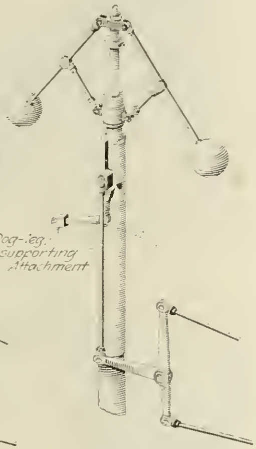


FIG. 2. A REASONABLY SAFE GOVERNOR STOP

In the original design of the governor on one of the insured engines, the contrivance for holding the governor balls at a starting plane when the engine was standing idle consisted of a brass collar with a projecting shelf and handle, encircling the governor standard, or supporting column, as shown in Fig. 1. It was presumed that after starting the engine the operator would turn the collar so that in the event of the governor belt breaking, the attached shelf would not keep the balls from dropping to the plane of safety, and that when shutting down he would shift it back again so as to catch the descending mechanism.

But there was about this device an obvious element of uncertainty that made it objectionable to the underwriters, so they ordered it taken off and the dog-leg attachment shown in Fig. 2 put in its place. The use of this is evident. When shutting down, the operator holds the dog-leg upright until the rectangular stud projecting from the governor sleeve rests upon it and thus secures it; then, when the engine is started and the governor balls rise, thus releasing the dog-leg, the latter promptly swings of its own overbalance, to the position indicated by the dotted lines.

But notwithstanding the automatic feature of this scheme, the personal element was almost as potent a source of danger as before. The engines were located in different parts of the mill, which occupied a city block, and were distantly separated from one another; the engine with the altered safety mechanism being kept in reserve. One night the bolts of a flange coupling that joined one of the main engine drives to the corresponding lineshafts were sheared off. This necessitated starting up the reserve engine, which transmitted its power to the system of shafting at the farther end. The main engine ran with a boiler pressure of 90 lb., but the reserve engine, being smaller, required 110 lb. The engineer speeded up the reserve engine with the boiler pressure still at 90 lb., but when the lineshaft load was thrown on by the closing of a friction clutch, the speed diminished until the safety cams intervened to stop the engine altogether. To keep the mill going while the fireman was raising the pressure to the necessary 110 lb., the engineer concluded to tie the dog-leg in the upright position with a piece of cord; standing by in the meantime and cutting the device loose when the pressure was high enough to keep the governor balls at the normal running plane.

Considering the circumstances, there was nothing censurable in this so far as the engineer was concerned. However, it afforded a pernicious object lesson to the boss of the mill hands, who was watching the proceedings. This person had formerly caused the engineer much annoyance by his habit of surreptitiously shifting the supporting collar around to the nonrunning position, his impression of the device being that it was a contraption put there simply to keep the engine speeded up. The dog-leg attachment presumably held him safe in this regard until he saw how easily its automatic feature could be nullified. At any rate when the engineer was making his periodical round of the plant an hour or so later, he found the dog-leg tied snugly to the governor post with its business end up. Subsequent events showed that his vigilance was timely. About half an hour later the worn-out lacing of the governor belt broke. A. J. DIXON.

St. Louis, Mo.

Handling Superheaters During the Starting-Up Period

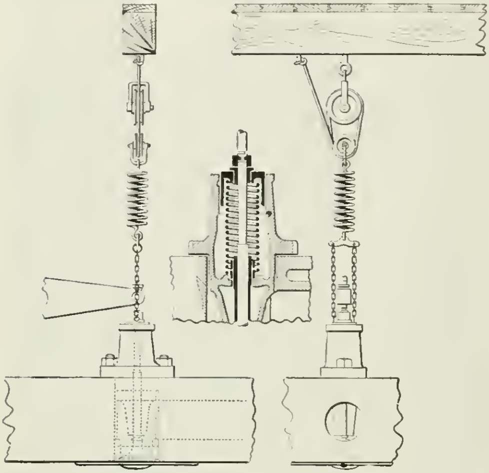
A difference of opinion arose recently in a group of engineers with regard to the handling of superheaters during the starting-up period. Some maintained that the superheater had to be—or at least ought to be—full of water at this time, while others said that boilers were always—or at least usually—started up without paying any attention to the superheater.

Will not the readers of *Power* help us to get at the facts by telling what their own practice is—and why?

New York City. F. L. RICHARDS.

Breaking of Diesel-Engine Valve Springs

With certain makes of vertical Diesel engines considerable trouble is caused by the breaking of the suction- and exhaust-valve springs. Since it is impossible to operate the engine with a spring broken, such an accident entails the cutting out of this particular engine. This is a source of much criticism in some plants where the service is dependent entirely upon a single Diesel-engine unit.



MAKESHIFT TO OVERCOME BROKEN-SPRING TROUBLE

In an industrial plant containing a single 325-hp. vertical Diesel, this trouble was solved in an unusual and clever manner. Directly above each valve an eye-bolt was placed in the ceiling. The valve dashpot piston or cap was drilled and tapped in two places and two small eye-bolts were inserted with locknuts on the inner side of the cap. If a spring broke, a spring with two hook chains was connected to the cap in the manner shown in the sketch, and a small tackle-block connected the other end of the spring to the ceiling eye-bolt. The proper tension could then be given the spring. In this way the valve continued to function until the engine could be shut down after working hours. Such a device can be fitted to any engine of either horizontal or vertical type.

E. E. Snow.

Philadelphia, Penn.

Ventilating Horizontal-Shaft Waterwheel Driven Alternators

Our metallurgical plants are supplied with power from an adjoining hydro-electric plant in which there are seven 5000-volt alternators having a total capacity of 15,000 kv.-a. The alternators are of the horizontal-shaft type, not adapted to artificial ventilation as is the modern steam-turbine driven machine with a different form of housing.

The atmosphere of the power plant becomes heavy with smoke and dust from the metallurgical plant, and as a result the generators get in very bad condition and require frequent cleaning. We wish to install an artificial ventilating system so as to keep the air clean in the power plant. By doing so the machine would operate satisfactorily. We do not know of any such installations in our own country and would appreciate very much hearing from some of *Power's* readers in America how they have handled such problems.

Charles A. Keller, President,
Societi des Etablissements Keller et Leleux.
3 Rue Vignon, Paris, France.

Effect Economy by Changing the Hot-Water System

At a certain steam plant it was necessary to turn the exhaust steam through the heating system, thus robbing the hot-water supply heater of its share of exhaust steam. Consequently, live steam had to be used, and to reduce its use a ½-in. vacuum line was connected, as shown in Fig. 1, to the pipe connecting with the hot-water heater. When a vacuum was put on the heater, enough exhaust steam was pulled through it to raise the water up to 200 deg. F. The vacuum pump discharges to the feed-water heater.

At this same plant 8 lb. back pressure is carried on the exhaust-steam line of a hot-water heating system. At the end of the 1200-ft. 3-in. pipe line properly covered, but very few heat units were found at the hot-water heater to heat the circulating water. There is also above the 3-in. line a 5-in. line under 50-lb. pressure which is used only now and then. A connection was made from this line to the 3-in. line, which was then discarded. A thermostatic valve was connected in the vacuum-return line, as shown in Fig. 2.

After making this change the outgoing circulating water had a temperature of 188 deg. when the returns were passed through the thermostatic valve, and it was from 210 to 220 deg. when the vacuum pulled from the heater.

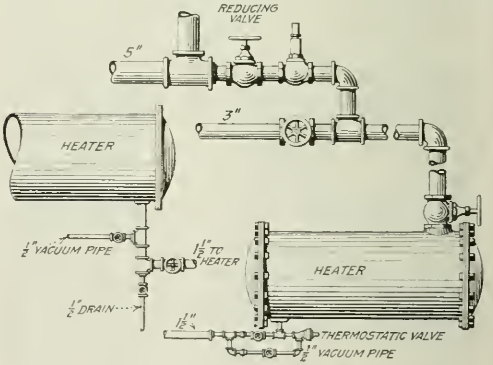


FIG. 1. VACUUM PIPE CONNECTION

FIG. 2. CHANGED PIPING ELIMINATED 3-IN. LINE

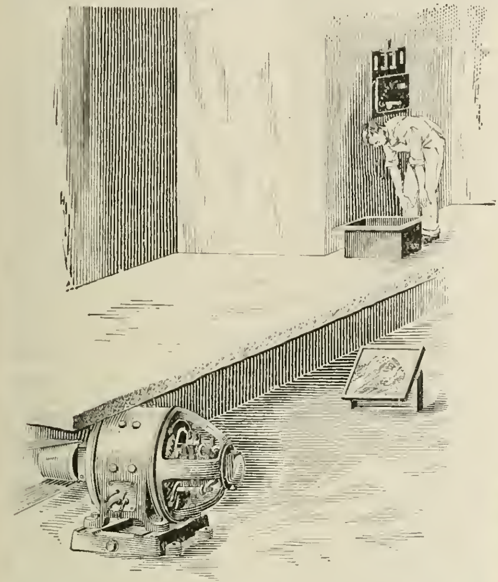
Less current was used by the motor, owing to the increased heat of the circulating water, and, being less dense, it had a tendency to circulate itself.

The recovery of 1200 ft. of 3-in. pipe, fittings and covering, practically new, less condensation in the 5-in. line, owing to increased circulation, and the saving of exhaust steam that could be used for other purposes, were the results of these changes, and these overbalance the fact that live steam is now used on the system.

Memphis, Tenn. J. A. Landolina.

Mirror for Observing Motor

We have used a device similar to the periscope described on page 716 of the May 13 issue, in connection with a 50-hp. direct-current motor driving a rubber calender. There was not sufficient floor space to accommodate the motor, so we placed it in the cellar and connected it to the calender with a silent-chain drive. We placed the starter conveniently for the operator and cut a hole through the floor, placing a mirror at an angle so the motor could be seen from the starting panel. Thus, any excessive sparking or similar troubles can be detected at once. C. B. Brush.


OBSERVING A MOTOR BY MEANS OF A MIRROR

New York City.

Installing Disconnecting Switches

In reading W. H. DeMuth's article in *Power*, page 740, May 13 issue, I get the impression that a circuit can be opened on a disconnecting switch with very little trouble. I believe a word of caution would be timely on this subject. The ordinary disconnecting switch, as supplied by the manufacturers of today, would be very unsafe to open under load conditions for circuits of 2300 volts and above.

I have before me a photograph of a lever switch opening a circuit under load with 13,000 volts on the line, and the arc rises eight to ten feet in the air. Indeed, an arc on a 600-volt circuit will easily reach four to six inches with only a few amperes load, especially if the circuit is inductive. Insulators for disconnecting switches are usually designed to stand from 2½ to 3 times the rated voltage. The distance, therefore, from the live parts to ground is very small as compared to the length of an arc that would occur when the switch was opened under load. A ground would be the result even if the line spacing was otherwise sufficient. Disconnecting switches are often called upon to open magnetizing current of power transformers and charging current of transmission lines. This should be considered the maximum of their current-rupturing qualities.

An operator who has the habit of hurriedly opening disconnecting switches without knowing the current that they are carrying will have plenty of time afterward to gather his thoughts while new switches are being installed or perhaps a new station built.

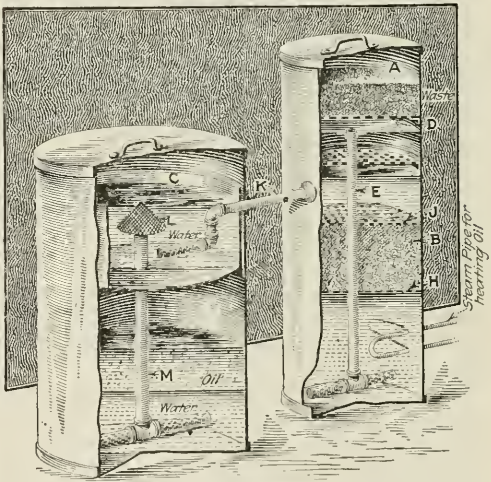
Milwaukee, Wis. H. D. Matthews.

An Efficient Oil Filter

In a plant where I was employed there was a galvanized filter of the construction shown in the illustration. It cost the tinner $5 to make. The tank *A* is 10 in. high and 4 in. in diameter, tank *B* is 28 in. high, and tank *C*, which contains a wire-gauze strainer, is 14 in. in diameter and 8 in. high.

This filter meets the requirements of three generators and one engine, all being equipped with oil cups. The oil to be filtered is placed in the tank *A*. It then passes through a bed of waste that is supported by a perforated guard *D* and drains into the pipe *E* leading to the bottom of the tank *B*. The bottom of the pipe is T-shaped, the horizontal pipe being perforated to allow the oil to escape in small drops and filter up through the water contained in the tank below the lower layer of waste.

This serves to cleanse the oil, a considerable proportion of the gritty material falling to the bottom of the tank. The oil then passes through the waste bed that is secured between the lower and upper guards *H* and *J*. It is then conveyed by the pipe *K* from the bottom of the pan in the tank *C*, where it is again washed by rising through water. After reaching the surface of the water, the oil passes through a wire-gauze strainer *L* attached to a vertical pipe *M* leading to the bottom of tank. There it is again washed, finally rising to the surface of the water, when it is ready to be drawn off for use in the oil cups. J. C. Kahl.



SECTION THROUGH OIL FILTER

Columbus, Ohio.

Maximum Length of a Longitudinal Joint in a Boiler

I have read the editorial entitled, "What Should Be the Maximum Length of a Longitudinal Joint in a Boiler?" and I can see no reason whatever for limiting the length of a barrel on account of any type of joint. If a barrel ten or twelve feet long is safe, it would be just as safe, from a theoretical standpoint, to make it one hundred feet long.

I do see some reason for restricting lap joints, but the reasons are all inherent in the action of the joint, regardless of the length of the barrel sheet. From a safety standpoint lap joints should be eliminated entirely and the test specimen for the material in the barrel should have its lengthwise dimension in line with the circumference of the barrel. In other words, if the longitudinal dimension on the sheet is laid circumferentially around the boiler, the test specimen should be taken longitudinally from the sheet. If, on the other hand, the lengthwise dimension of the sheet is parallel with the center line of boiler, the test specimen should be taken at right angles to the lengthwise dimension of the sheet W. F. Kiesel, Jr.

Altoona, Penn.

Experience with Automatic Indirect Heating System

I once took charge of an automatic, indirect, double-duct heating system, having had but little previous experience in similar operation. In my opinion this kind of heating system is an ideal one to heat and ventilate a building, especially a school. The air remains uniformly sweet and at a steady temperature, it is quick to heat in the morning and may be quickly regulated to follow sudden changes of weather.

To obtain such results, however, the operator must be sure that the air valves of the stacks are working properly. Mine are all supplemented with petcocks which are left partly open, those inside of the ducts thus helping to humidify the air, no special provision being made to that end.

The main thermostats at the reheated- and tempered-air chambers must be watched and also such rooms north and south of the building, from which a general idea can be had of the temperature of the remaining parts that are not of easy access.

The fans should never be started until the stacks are thoroughly heated and the air compressor, actuating the motors, is in full operation; also not before the main thermostats are set for quick heating. My system is divided into two independent parts, north and south. Each part has one high-speed engine and three thermostats: One, called the outside one, actuated by the atmospheric temperature, opens steam to the top tier at 36 deg. F. or below; one for tempered air, which I set at about 36 deg. F. for north and 32 deg. F. for south; and the last one on the reheated air, which I set for 100 or 120 deg. F. in cold weather. These temperatures must be reduced as the day becomes warmer. Here is where the guesswork comes in and keeps the man watching the results of the resetting of the main thermostats.

Do not allow opening of doors or windows to the outside. Be sure of this; it is hard to believe no fresh air can thus be obtained. Release a piece of paper at the opening and, if the system is in operation, the paper will fly out, not in, as some would expect it to do. This error not only is very wasteful of coal but will impair the heat regulation through the building.

In systems exhausting directly on the roof, the dampers of the exhausted ducts must be closed when shutting down the plant and opened when restarting. Systems exhausting in a garret, hence to the atmosphere, have the advantage of permitting recirculation of the same air at will when the building is vacant, thus saving coal. Sometimes I found that open exhaust dampers during the night allowed cold back draft into the room. This occurs in the daytime when the plant is in operation, and then if the thermostat happens to be installed in the foul-air duct, it remains cold and the room will become greatly overheated. This is as much an offense in a school as underheating.

When a room becomes underheated or overheated, do not do as I first did—make a bee line for the thermostat—but see what is the cause. It may be that the duct dampers controlling the air volume for that room have shifted through vibration, that the regulating motor dampers are stuck or that the rubber diaphragm of the motor is leaking, thermostat passages obstructed or that the thermostat has been tampered with by someone having a key. I overcome this by keeping tab of the figures at which I left the instrument set. Underheating may be due to temperatures too low in plenum rooms, air compressor inactive, steam back-pressure too low, engines not at proper speed, broken panes in windows or wind impinging against windows, etc.

One of the few drawbacks of this system is shown in mild weather when the steam consumption cannot be reduced to less than what it takes to keep the engines to proper speed, when the excess back pressure forces the back-pressure valve and exhausts in the atmosphere. In such a case do not be tempted to reduce the engine speed. Do not waste time trying to keep the thermostat indicator figure to correspond exactly with the thermometer, but use such a figure as a datum to go by. The instrument might have to be set at 64 deg. F. to obtain a 68-deg. F. temperature in the room; record such a figure near-by on the wall, or in a book. Do not allow anything to be hung on or near the thermostat.

I would deem a system ideal if designed so that the incoming air is filtered and automatically moistened; when both the reheated and tempered air is mixed long before it reaches its destination; when all the ducts are air-tight and thoroughly insulated, and when it is possible to recirculate the same air when the building is vacant and in need of heat to prevent freezing. A. Fisk.

Jamaica, N. Y.

Concrete Boiler Settings

On page 934 of the June 17 issue of *Power*, I notice in the first sentence of the article on concrete settings of boilers, that the engineers of Robert Gair Co. went so far as to use cinder concrete for boiler settings and used no firebrick lining. Have you any data on the results? This seems so absolutely contrary to all reason that I am very much interested in knowing how it came out. E. Marshall,

St. Paul, Minn. Electrical Engineer,

Great Northern Railroad.

Inquiries of General Interest

Brine Solution Too Strong—The valves and rods and part of the cylinders of our brine pump lately gather considerable salt crystals. What is the cause? M. C.

This is usually an indication of having too strong brine.

Regulating Forced Draft of Vertical Boilers—We have three 150-hp. vertical fire-tube boilers, operated by forced draft from a fan blower connected by a branch pipe with shutoff to each boiler ashpit, and in addition there is a damper in the main pipe from the blower that is controlled by a regulator. Would it not be better to leave these dampers wide open and regulate the draft by means of the uptake damper? F. A. C.

The present arrangement is better than regulation of draft by the uptake damper, because any time the latter chanced to be partly or entirely closed, the blower would build up excessive pressure in the furnace, causing hot gases and ashes to be blown out of the fire-doors.

Motor Wire Not All the Same Size—We have a 20-hp. induction motor operating on a 230-volt three-phase 60-cycle circuit. The motor is connected to the starting device with two No. 3 and one No. 0 conductor. What effect if any has the difference in size of conductors on the operation of the motor? W. P. B.

It is doubtful if the machine in question is a three-phase motor, but more likely a 3-wire two-phase machine, although the former may be correct. In 3-wire two-phase systems the cross-section of the center wire is usually made 1.414 times that of one of the outside wires; this to take care of the current in the center leg of the system, which is 1.414 times that in one of the outside legs. However, if your machine is a three-phase motor, the one larger wire will have little effect on the operation of the motor. It would have a tendency to unbalance the voltage of the three phases, but this will be so slight as to be practically negligible.

Glass Gage for Pump Air Chamber—What should be the height of a glass gage on an air chamber of a pump that operates against a gage pressure of 105 lb. per sq.in.? J. W. C.

With a discharge pressure of 105 lb. gage or about 120 lb. per sq.in. absolute, the air contained in the air chamber at atmospheric pressure would be compressed to about $\frac{15}{120}$ or $\frac{1}{8}$ of its original volume. If the air chamber is a vertical cylinder, the water level would be raised to within about $\frac{1}{8}$ the height measured from the top. With a pear-shaped air chamber having the lower or conical portion about 3 times as long as the diameter of the hemispherical top, the water level would rise to within about $\frac{1}{3}$ of the diameter below the top of the air chamber. For indicating the conditions, it is well to have the glass gage connections so arranged as to show any standing of the water level from the top down to about one-half the total depth of the air chamber.

Compound-Wound Motor Reverses When Starting—What would cause a compound-wound motor to reverse its direction of rotation upon reaching the third point of the starting rheostat? What would cause the same motor to run within normal speed limits at one starting and accelerate to a dangerous speed at another starting? H. W. C.

The trouble is caused by the series- and shunt-field windings being connected in opposition. The starting resistance was cut out at a rate that allowed the armature current to build up to a value, when the third point of the starter was reached, that made the ampere-turns of the series winding greater than the shunt-winding ampere-turns. This reversed the polarity of the polepieces and consequently reversed the direction of the motor. In general, if a compound-wound motor with its field winding connected in opposition is starting under light load and is accelerated slowly, it will come up to normal speed without giving any evidence of anything being wrong. However, if an attempt is made to accelerate the same motor rapidly, it will reverse before the starting resistance is cut out, as explained in the foregoing, or it may run at a dangerous speed due to the demagnetizing effect of the series-field winding.

Discharge Through Part Open Globe Valve—A 2-in. disk globe valve in a feed line has a valve stem with six screw threads to the inch. When the valve is open one-eighth of a turn with 170 lb. pressure on the boiler and 178 lb. pressure on the feed line, how much water should pass through the valve in an hour? J. W. C.

The velocity of water discharged through the valve from a pressure of 178 to 170 lb. per sq.in. would be the same as for a difference of head of $(178 - 170) \div 0.433 = 18.48$ ft., and for that head the theoretical velocity would be $\sqrt{2gh} = \sqrt{2 \times 32.16 \times 18.48} = 34.48$ ft. per sec., or $34.48 \times 12 \times 60 \times 60 = 1{,}489{,}536$ in. per hour. If backlash of the screw is taken up, the lift of the valve for one-eighth of a turn of the stem would be $\frac{1}{8}$ of $\frac{1}{6} = \frac{1}{48}$, or about 0.02 in., and for a valve seat with 2-in. diameter of aperture there would be an annular opening of $2 \times 3.1416 \times 0.02 = 0.126$ sq.in. The coefficient of discharge would be approximately 0.6, depending on the form and roughness of the valve, and the actual discharge would be about $0.6\ (1{,}489{,}536 \times 0.126) \div 231 = 487.5$ gal. of water per hour.

Horsepower of Pump—What is meant by the horsepower of a pump? H. P. R.

Five different values of horsepower of a pump must be distinguished: (1) The indicated horsepower of the steam end, obtained from indicator diagrams of the steam end in the same way as determining the indicated power of a reciprocating engine; (2) the brake horsepower, or power actually transmitted to the pump, and which in a direct-acting steam pump would consist of the indicated power of the steam end less the friction of parts essential to operation of the steam end; (3) the indicated horsepower of the water end, obtained from indicator diagrams taken from the water cylinder to determine the power transmitted by the water piston or plunger; (4) the water, or developed, horsepower to express the useful work done by the pump, based on the actual weight of water discharged and total height through which the water is elevated; (5) what is commonly recognized as the nominal horsepower, which is based on the weight of water that would be displaced per minute by the plunger or piston if there were no slippage, combined with the discharge pressure plus the lift measured from the water level in the suction well to the height of the discharge gage. Thus, if the plunger or piston displacement is 1000 gal. per minute, it would be assumed that the pump actually handled $1000 \times 8\frac{1}{3} = 8333$ lb. of water per minute; and if the discharge pressure indicated 40 lb. per sq.in. and the height of the gage was 16 ft. above the water level of the suction gage, the total lift would be considered as equivalent to (40 lb. × 2.3 ft. per lb.) + 16 ft. = 108 ft., making $8333 \times 108 \div 33{,}000 = 27.27$ nominal pump horsepower.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Boiler-Water Treatment*

IF YOU cover a steam pipe with asbestos, magnesia or other heat-insulating material, you keep the heat in the steam; if you line or coat a boiler tube with scale or other heat-insulating material, you keep the heat out of the boiler water and send it to the stack. By lagging your pipes you save fuel easily. By lining your tubes with scale you waste it continuously and needlessly.

All natural waters contain more or less of this heat-insulating material, partly as suspended matter (clay, fine sand, insoluble forms of iron, aluminum, etc.), partly as dissolved matter, such as compounds of calcium, magnesium, sodium, potassium and other mineral salts.

Much of the suspended matter, as well as most of the dissolved matter, may form scale, but the suspended matter may generally be removed by filtration, which will be discussed later.

Dissolved Matter Which Forms Scale

Of the material commonly in solution in boiler waters, the bicarbonates and sulphates of calcium and magnesium are the most important scale formers. Natural waters containing in solution bicarbonate of calcium or magnesium or both exhibit what is called "temporary" or "carbonate" hardness; those containing dissolved calcium or magnesium sulphate or both possess "permanent" or "sulphate" hardness. In the case of the sulphate scale the temperature required to separate it is too high to make its removal by heating alone a practical means of treatment. In the case of water exhibiting carbonate or temporary hardness great improvement in its properties may be effected by the use of open heaters of the exhaust-steam type. As a rule sulphate scale is denser in structure with a higher heat-insulating value than carbonate scale, but the conditions of formation affect this considerably. Where a porous structure permits water to penetrate the scale, its heat-insulating effect is greatly reduced.

The Effect of Scale

In many respects the effect of an increasing deposit of scale on the passage of heat through the walls of a boiler tube is very similar to the effect on the passage of water through a tube of continually decreasing bore. In the case of the water tube, the only way to get a uniform volume of water through it in a given time, in spite of its diminishing bore, is continually to increase the pressure in the water; so in the case of a boiler tube covered with a dense scale the only way to maintain a constant flow of heat from the furnace to the boiler water is to increase the "heat pressure," so to speak; that is, to burn more fuel.

The most important effect of scale is due to the fact that in certain forms it is a wonderful heat insulator. Its chemical composition seems to have little to do with its heat-insulating power, the big question being the density or mechanical structure of the scale. A series of experiments by Professor Schmidt, of the University of Illinois, gave the results given in the table, showing decrease in heat-transfer efficiency of tubes coated with scale of different thickness and composition.

DECREASE IN HEAT-TRANSFER EFFICIENCY CAUSED BY SCALE

Character of Scale	Thickness, In.	Composition	Loss of Efficiency, Per Cent.
Hard	$\frac{1}{50}$	Mostly carbonate.	9
Soft.	$\frac{1}{32}$	Mostly carbonate.	7
Hard	$\frac{1}{32}$	Mostly carbonate.	8
Soft	$\frac{1}{25}$	Mostly carbonate	8
Hard	$\frac{1}{25}$	Mostly sulphate.	9
Hard...	$\frac{1}{20}$	Mostly sulphate.	11
Soft....	$\frac{1}{16}$	Mostly sulphate	10
Soft....	$\frac{1}{16}$	Mostly carbonate	11
Soft...	$\frac{1}{16}$	Mostly carbonate	12
Hard....	$\frac{1}{16}$	Mostly carbonate	12
Soft....	$\frac{1}{11}$	Mostly carbonate	15
Hard.....	$\frac{1}{9}$	Mostly sulphate ..	16

This expressed in dollars and cents means that with a deposit of $\frac{1}{9}$ in. of scale, 16c. of every dollar paid for coal is lost.

The data just given must not be regarded, however, as indicating that the decrease in the heat-carrying capacity of scale-covered tubes can always be calculated with the accuracy that these figures would indicate. The important facts are, though, that the loss is easily prevented and that the advantages of soft water abundantly justify all expenditure necessary to secure it.

Means of Removing "Scale Formers" from Water

The methods employed in softening water may be divided into two main classes, those in which the scale-forming property is removed before the water enters the boiler, and those in which the softening is effected within the boiler itself by means of so-called "boiler compounds."

As to which one of the two classes of methods should be employed in any particular case would depend on the size of the plant and on the character of the water to be softened. In the case of waters of abnormal composition it would frequently be impossible to produce a satisfactory water by either method and a new water supply would be necessary.

It cannot be too strongly emphasized that this question of water treatment is one in which the employment of competent chemical and engineering knowledge is both absolutely necessary and highly profitable, and it would be far wiser to omit all forms of water treatment (involving the use of chemicals) rather than to undertake such without knowing accurately the composition of the water and of the material used to soften it. It is most important to remember that the quality of the water, even when secured from the same source, varies widely from time to time. These variations are not only seasonal and monthly, but daily and even hourly. A condition of excessive concentration of the water after a protracted drought may be changed within an hour to a correspondingly excessive dilution by a summer storm. The result would be to decrease enormously the percentage of dissolved matter and to increase, probably to a much greater degree, the amount of suspended matter.

As a consequence a prescribed treatment of the water based on its analysis at any particular time might not lead to satisfactory results if applied at some other period.

As an instance of the serious danger of an unintelligent "dosing" of boiler waters may be cited the results of a long series of investigations which have, apparently, shown that carbonate of soda in solution produces brittleness in boiler steel. Carbonate of soda (soda ash) is used in most water-treating processes and its unintelligent use may readily lead to a very dangerous condition in a boiler.

When Boiler Compounds May Be Used

Boiler compounds afford a useful means of boiler-water treatment in plants whose size or value of output would not justify the use of a more expensive method. This would be true of a large percentage of the plants of the country.

In spite of a great variety of trade names a very large percentage of all boiler compounds consist most largely of carbonate of soda, to which caustic soda is sometimes added, and occasionally phosphate of soda. Starchy materials and those containing tannin are frequent ingredients. The supposed effect of these last two materials is to coat the particles of precipitated incrusting material and prevent its cohesion into compact scale.

The chief disadvantage (assuming that they are used intelligently) is the necessity of frequently blowing down the boiler to prevent the accumulation of "sludge" and of alkaline (sodium) salts in the water, both of which cause foaming. Furthermore, this blowing down must be supplemented by washing out, and occasionally closing down the boiler to complete the removal of the sludge and of the boiler compound itself

Whenever competent supervision of boiler-water treatment is available within the plant organization, it is preferable to soften the water before it enters the boiler, and this must be done when the percentage of scale-forming ingredients is high.

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*From one of the bulletins distributed by the Fuel Administration and the Bureau of Mines.

By Treating the Water Before It Enters the Boiler—The removal of scale-forming components from water by chemical means, whether before or after entering the boiler, is accomplished by converting the calcium and magnesium compounds into practically insoluble forms, causing them to separate from the water and allowing the material to be removed by blowing down, filtering or sometimes by settling. Lime and soda ash are generally used for this purpose when the softening occurs before the water enters the boiler. The lime combines with the carbon dioxide which held the calcium and magnesium carbonates in solution; these are no longer soluble in the water after removing the carbon dioxide, and therefore separate from it. In a similar way the sulphate scale is removed by its conversion to insoluble carbonate by the soda ash.

The Lime-Soda Process—There is in current use in power plants practically only one lime-soda process, of which there are two varieties differing chiefly in the temperature of the water when treated. In all essential respects the two varieties are similar. The treatment consists of adding to the "raw" water softening agents in carefully controlled amount (which must agree with the composition of the water), mixing these thoroughly within the water, and permitting sufficient time to elapse for the separation of the "sludge" before the water is fed to the boiler.

In the case of the "hot-continuous" process this separation is effected more rapidly, which permits of less storage capacity than in the case of in the cold-continuous. In all cases, though, it is of the utmost importance to provide sufficient storage space to allow the sludge to be completely deposited before the water is fed to the boiler; otherwise the partly completed softening process will be completed within the heater, and the purpose of the treatment will be largely defeated. Another advantage of the hot process is that it expels the air from the water and so reduces the corrosion.

The Zeolite Process—This is entirely unlike the processes already described and (unlike them) gives a water of zero hardness. The softening agent is an artificial material composed largely of sodium compounds, which are exchanged for the incrusting (scale-forming) material of the water; that is, the water dissolves sodium compounds from the softener and replaces it by the calcium and magnesium which had caused the hardness of the water. The hard water simply flows over the permutit packed in a cylinder or is forced up through it and flows from it with all scale-forming material removed. After a time the softener must be regenerated by allowing a solution of salt to flow over it, restoring its original composition and activity. The "permutit" process is a well-known efficient variety of the zeolite treatment.

ADVANTAGES AND DISADVANTAGES OF ZEOLITE PROCESS

The construction and operation of this softening equipment is extremely simple. On the other hand, in the case of water of a high degree of temporary or carbonate hardness there is a correspondingly large amount of sodium salts introduced into the water so that foaming is liable to occur (as is liable to occur when softening water of a similar composition by means of boiler compounds). In such cases the following modified form of the zeolite process is used.

In this an intermittent or continuous tank equipment, as described already under the lime-soda process, is connected through a filter to a zeolite softener. Only lime is used in the tank, the soda compound being secured from the zeolite. The filter is placed between the tank and the zeolite softener to avoid any sludge coating the permutit particles and so impair its efficiency.

No process of water softening is satisfactory unless the amount of suspended matter is reduced to a minimum. In the case of very finely divided matter this may be done by adding so-called coagulants—alum, for example—but these should be used with extreme caution and always under expert direction. Ordinarily, though, such suspended matter is removed by filters, of which the sand filter with a down flow of the water is the most satisfactory type. They are not expensive either in original or maintenance costs.

The purpose of the methods described is to prevent the formation of scale. There is another class of water-treating material used largely to remove scale already formed and to some extent prevent the formation of new scale. Graphite and kerosene are most often used for these purposes. Their action seems entirely mechanical.

Opinions as to the desirability of their use vary from enthusiastic commendation to absolute condemnation, though their use seems generally approved by practical men. Neither should be used, however, in boilers in which there is already a heavy deposit of scale, as the loosening of this and its accumulation in the bottom of the boiler is likely to lead to blistered and bagged boiler metal.

SOME EXAMPLES OF ECONOMIES EFFECTED BY SOFTENING WATER

There is a very direct relation between softening water and saving fuel; the following are a few cases reported of such economies.

1. A marble company reports a saving of 21 per cent. of fuel by softening its boiler water.
2. A crucible steel company, by substituting soft for hard water, effected a saving of 3600 tons of coal per annum, which based on current prices would be valued at about $22,000.
3. The Chicago & Northwestern Railroad Co., comparing its operating expenses in 1902-3 before and after softening its water supply reported a saving of $75,000 per annum. This saving was effected at a period when coal cost probably less than one-half the prices charged to-day (1918).
4. In addition to these, other cases have been reported in which the profits resulting directly from the substitution of soft for hard water have been reported as varying from 32 per cent. on an investment of $7200 to 71 per cent. on an investment of $7000. These profits resulted largely from the elimination or reduction of operating costs, such as cleaning heaters, piping, and economizers, cost of cleaning instruments, interest, and depreciation of spare or idle boiler, etc.
5. Furthermore, it has been estimated that the use of hard water in a great number of the locomotive boilers of the country involves the consumption of 15,000,000 tons of coal more than would be needed were soft water only used.
6. A steel company whose annual output is 50,000 tons reports a saving of 200 lb. of coal per ton of steel resulting from the softening of its boiler water.

A Suggested Formula for Rating Kerosene Engines*

By D. L. ARNOLD

Among the various companies manufacturing kerosene engines there seems to be no uniform standard of rating in use, and as a result engines of the same bore, stroke and speed—or in other words, of the same piston displacement per minute—are given different ratings by almost as many manufacturers. For instance, one buys an engine of 4 hp. that will actually develop 6.5 hp.; someone else buys one also rated 4 hp., but it will develop only 5 hp., and it will in all probability have a different piston displacement per minute. Apparently this means nothing as far as the customer is concerned, for in each case he receives more horsepower than he believed he was purchasing. A great difficulty does, however, arise when these engines are judged by the amount of maximum work which they will perform in a given length of time, not on brake tests but on users' equipment, and the result is that the purchaser of the smaller engine is greatly dissatisfied, despite the fact that his engine will develop a 25 per cent. overload.

The foregoing is only a sample case of the inconsistency that has resulted in many bills now being introduced, or about to be introduced, in state legislatures, specifying how an engine shall be rated. If these bills should all pass it might be that each state would require a different rating, and thus the manufacturers would be obliged to furnish a different name-plate in each state. It would therefore seem advisable for the manufacturers to get together and adopt a standard rating for kerosene engines; and this work would be greatly facilitated if the engineers of this society and of the Society of Automotive Engineers would coöperate and adopt a standard rating for this type of power plant.

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*Presented at the Spring Meeting, Detroit, Mich., June, 1919, of the American Society of Mechanical Engineers.

FORMULAS NOW IN USE FOR FOUR-STROKE-CYCLE ENGINES

D = Diameter of piston, in.
L = Length of stroke, in.
n = Number of cylinders.
N = Number of revolutions per minute.

No.	Authority	Formula
1	N.A.C.C.* or A.L.A.M.	$\frac{D^2n}{2.5}$ (at 1000 ft. per min.)
2	E. P. Roberts	$\frac{D^2LNn}{18,000}$
3	French Automobile Club	$0.45D^2n$ (at 985 ft. per min.)
4	Royal Automobile Club, British	$0.405\ D^2n$
5	Royal Automobile Club, Swedish	$\frac{D^2L\ Nn}{15,240}$
6	Prof. H. L. Collanders	$0.565\ D\ (D - 1)n$
7	T. Thornycrofts	$\frac{D^2L^{0.75}n}{2700}$
8	M. Faroux	$0.121\ D^{2.4}L^{0.6}$
9	M. Arnon	$0.1\ D^2n$
10	E. W. Roberts †	$\frac{D^2L\ Nn}{X}$

* Vol. 1, p. 30, S.A.E. Standards Data Sheets.

† Gas Engine Handbook, p. 131. X is a factor varying with the fuel and cycle. For 4-cycle engines X equals 16,000 for natural gas and 14,000 for gasoline.

If standard rating is to be of service, it must give equal protection to the manufacturer and the customer, and any formula which is obtained must therefore be based upon practice covering a sufficient period of time. Before taking up the proposed formula, however, the writer wishes to review some of the formulas that are in use today and which are listed in the table.

The A. L. A. M. formula[1] is based on the assumption that there is developed within the cylinder a mean effective pressure of 90 lb. per sq.in., that the engine operates with 75 per cent. mechanical efficiency, and that the piston speed is 1000 ft. per min. With ungoverned engines this formula is perhaps as good as any, but for engines operating with governors it is obvious that if a piston speed of other than 1000 ft. per min. is maintained, it will be necessary to make a correction to cover this point, in which event the formula is unwieldly and inconvenient.

An empirical formula[2] which is considered as very conservative practice when compared with the various ratings now used by engine manufacturers, is as follows: B.hp. $= 0.00006042\ D^2LNn = V/13{,}000$. Before deriving this formula the writer compared the ratings of 115 engines manufactured by 61 companies and found them to vary from 8256 to 19,985 cu.in. per b.hp. Forty-six engines were rated using 11,000 cu.in. or less as 1 b.hp.; 29 used 11,000 to 12,000 cu.in.; 12 used 12,000 to 13,000 cu.in.; 10 used 13,000 to 14,000 cu.in. and 18 used above 14,000 cu.in.

It will thus be seen that 87 engines, or approximately 75 per cent., were rated as using less than 13,000 cu.in. per b.hp., and while this value may be more conservative than some manufacturers might wish to use, it gives a standard basis of comparison and allows the engine to develop a fair percentage of overload above its rating, since any engine should be able to develop as a maximum 1 b.hp. per 11,000 cu.in. piston displacement per minute when the engine is in good condition.

With reference to the rating of four-stroke-cycle engines, it would seem best for all concerned that this rating should be made the nearest whole horsepower to that determined by the standard formula, it being an easy matter to change the rated speed of the engine in order to accomplish the exact rating. In any event, however, the rated horsepower would not, if the foregoing condition is adhered to, vary more than plus or minus 0.5 hp.

In considering the internal-combustion-engine rating we must also consider the tractor rating as the internal-combustion engine forms its power unit and the tractor rating is therefore dependent upon the engine rating. The owner of a tractor is interested not only in the amount of power that can be delivered by the engine, but also in the amount that can be delivered to the drawbar at the different speeds. Here again, however, manufacturers have been inconsistent in the ratings they have made. The majority of manufacturers have followed the rule that drawbar horsepower should be considered as 50 per cent. of the rating of the power unit, and in actual practice covering many years of experience this seems to be a very conservative figure to use. It is true that the tractor will often develop greater drawbar horsepower, but when taking into consideration the wide range of conditions through which the tractor must work, such as changes of soil and class of work, a 50 per cent. rating for the drawbar pull seems on the whole to be the best value to use.

The following formulas are those which it would seem are best adapted to the rating of internal-combustion engines and tractors:

$$\textit{Rated engine horsepower} = \frac{0.7854\ D^2LNn}{13{,}000} \qquad (1)$$

$$\textit{Drawbar horsepower} = \frac{\textit{Rated engine horsepower}}{2} \qquad (2)$$

$$\textit{Drawbar pull, lb.}^{3} = \frac{375 \times \textit{rated drawbar horsepower}}{\textit{travel in miles per hour}} \qquad (3)$$

$$\textit{Motor torque,}^{4}\ \textit{in.-lb.} = \frac{63{,}025.21 \times \textit{brake horsepower}}{N} \qquad (4)$$

Practical work in experimental testing laboratories and on regular test floors has proved that four-stroke-cycle engines operating on kerosene will develop for periods of two hours or more 1 b.hp. per 11,000 cu.in. piston displacement per minute and a few engines have for short periods of time developed 1 b.hp. for every 9800 cu.in. piston displacement per minute. Therefore, making allowances for general wear, mishandling and improper adjustment, the formulas given will be seen to be conservative and well adapted for the rating of this type of engine.

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[1] Derivation of A.L.A.M. Formula:

Let, HP_b = brake horsepower
HP_i = indicated horsepower
HP_r = rated horsepower
A = area of piston, sq.in.
D = diameter of piston, in.
E = mechanical efficiency (assumed at 0.75)
L = length of stroke, in.
n = number of cylinders
P = means effective pressure, lb. per sq.in. (assumed at 90 lb.)
V = piston displacement per minute, cu.in.
N = revolutions per minute
s = piston speed, ft. per min. (assumed at 1000)

$$HP_b = HP_i \times E = \frac{1}{4}\,\frac{PAsn}{33{,}000}\,E = \frac{90 \times 0.7854\ D^2 \times 1000 \times n \times 0.75}{4 \times 33{,}000}$$

$$= \frac{D^2n}{2.489}, \text{ or for practical purposes, } \frac{D^2n}{2.5}$$

Also, since $s = \frac{2LN}{12}$

$$HP_b = \frac{90 \times 0.7854\ D^2 \times 2LN \times n \times 0.75}{4 \times 33{,}000 \times 12} = \frac{D^2LNn}{14{,}939} = 0.00006693\ D^2LN$$

and substituting V for $0.7854\ D^2LNn$

$$HP_b = \frac{90 \times V \times 2 \times 0.75}{12 \times 33{,}000 \times 4} = \frac{V}{11{,}733}$$

[2] Derivation of Empirical Formula:

$$HP_r \text{ (recommended)} = \frac{0.7854\ D^2LNn}{13{,}000} = \frac{V}{13{,}000}$$

$$HP_r \text{ (transformed)} = \frac{D^2LN}{16{,}550}n = 0.00006042\ D^2LNn$$

[3] Derivation of Drawbar Pull Formula:

Let F_d = drawbar pull, lb.
HP_d = drawbar horsepower
S = speed in miles per hour

$$\text{Then } F_d = \frac{HP_d \times 33{,}000 \times 60}{5280 \times S} = \frac{375\ HP_d}{S}$$

[4] Derivation of Motor Torque Formula:

Let HP_b = brake horsepower
l = length of brake arm, in.
W = lb. pull at end of arm
N = revolutions per minute
T = motor torque, in.-lb.

$$\text{Then } HP_b = \frac{2\pi\ lNW}{33{,}000}$$

$$T = \frac{HP_b \times 33{,}000 \times 12}{2\pi N}$$

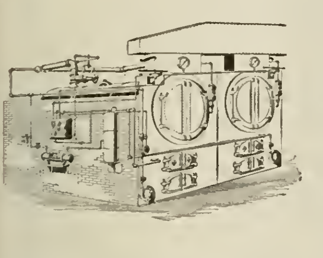
$$= \frac{63{,}025.21 \times HP_b}{N}$$

Condensed-Clipping Index of Equipment

Clip, paste on 3 x 5-in. cards and file as desired

Control, Oil Seal Combustion

Vapor Vacuum Heating Co., Otis Building, Philadelphia, Penn.
"Power," June 3, 1919

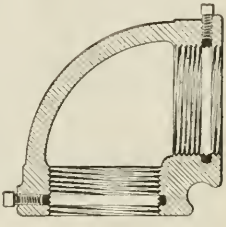


The system operates on the principle that the furnace of a boiler is the agent for determining the amount of draft to the chimney, and the quantity of air to be passed through the fuel bed to support combustion. When the steam pressure drops, the air applied to the furnace is increased. The position of the damper is changed in proportion to the quantity and pressure of gas generated in the furnace on account of the increase or decrease in the rate of combustion.

Fitting, Tight Joint

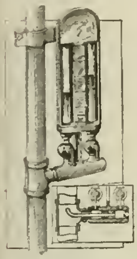
High Pressure Fitting and Valve Co., Inc., 72-74 Putnam St., Paterson, N. J.
"Power"

When using this fitting the pipe is screwed into it. The fitting is made with a lead joint or ring that extends slightly beyond the thread of the fitting. When the pipe is screwed into the fitting, it expands the lead packing, causing it to fill the threads. If the threads are not tight, one or more turns of the setscrews will crowd the lead around them, thus making the joint tight. The fitting is used for ordinary low-pressure work.



Indicator, Royer Flow

Sloan-Striker Co., Detroit, Mich.,
"Power," June 17, 1919

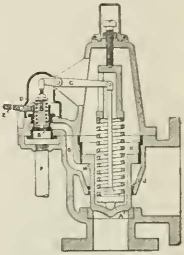


This instrument adopts the pitot tube with an inverted U-tube measuring the differential between the dynamic and static heads and indicating the flow in steam, gas or water or air lines. A chart is supplied with the instrument to assist in computing the quantity of flow. The scale is divided into tenths and may be calibrated into gallons per minute, cubic feet per minute, pounds per hour or any unit desired. In the case of gas or steam a second chart is used to correct the variations from the temperature or pressure at which the meter is expected to operate.

Valve, Full-Capacity Safety

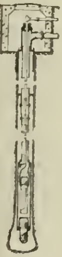
Atwood & Morrill, Salem, Mass.
"Power," May 27, 1919

This valve consists of a main and a pilot valve. The main valve is set at somewhat higher pressure than the pilot valve, and the movement of the main valve has a direct cutting-off action on the pilot valve; thus the valve will open to full capacity where there is a continued increase of pressure, but it will not do this at the first pop. The cutting-off action of a lever actuated by the main valve acts on a pilot-valve spring, and an upward movement of the pilot valve allows a flow of steam through a passage and acts on an annular surface and thereby opens the main valve.



Pump, Weber, Subterranean

Weber Subterranean Pump Co., 50 East 42d St., New York City.
"Power," June 17, 1919

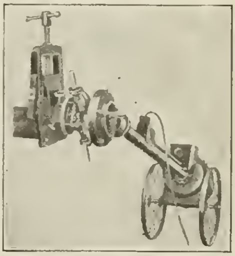


This pump is designed for lifting water from driven wells and operates with compressed air. It is of a displacement and internal exhaust type. Ball-check valves prevent water from falling back into the well. The intake chamber is from 4 to 10 ft. long, and the discharge pipe diameter increases as it approaches the ground level. The cage ball valves are made of bronze, the balls are hollow and are so balanced that the center of gravity is at the center of the valve.

Drive, "Toledo," Power

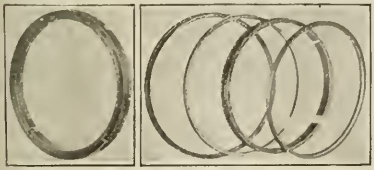
The Toledo Pipe Threading Machine Co., Toledo, Ohio.
"Power"

The "Toledo" power drive is a new electrically driven device for operating hand pipe-threading and cutting tools. It is portable. The motors are 1½ hp. and furnished for the necessary type of current. Each outfit includes 25 ft. of flexible cable fitted with a single plug connection. It is started and stopped by a push-button switch. It has a two-speed transmission gearing, and the change from one speed to another is made by pulling out or pushing in a knob.



Piston Ring, Blauvelt

F. N. DuBois & Co., 9th Ave. & 25th St., New York City.
"Power," May 20, 1919

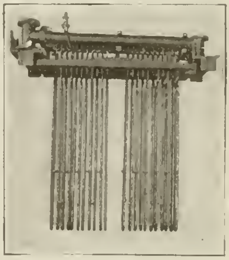


A piston ring designed for internal-combustion engines of the composite type is made up of a plurality of rings. The bull ring is grooved for an inner expansion ring, and two packing rings are mounted to encompass the carrier ring and the expansion ring. Each packing ring is beveled on its inner face against which the expansion ring bears, the bevel tending to move the two packing rings apart on the carrier ring. A single pin prevents the expansion and the two packing rings from turning, so that the joints of the rings cannot come together.

Superheater, Stationary Boiler

Locomotive Superheater Co., 30 Church St., New York City.
"Power," May 27, 1919

This superheater consists of two headers, one acting as a distributor for the saturated steam and the other as a superheated header for the collection of steam after it has been superheated. The headers are made of steel and are located outside of the hot gas path, usually outside the boiler setting proper. The tubes are bent and are connected to the headers by means of ball-and-socket joints with ground surfaces. The ball of the joint is forged on the end of the tube and fits into a ground seat in the header. The ball and seat are held in contact by means of clamps, bolts and washers. The superheater is built in units.



Patented Aug. 20, 1918

Amendments to New Jersey Boiler Code

At the meeting of the New Jersey Board of Boiler Rules, held at Newark, N. J., July 24, several amendments were incorporated in the New Jersey boiler code relating to new installations; a code was also adopted governing existing installations.

The factors of safety applying to old boilers are to be not less than the following: A factor of 4 for boilers not over 20 years old and 4¼ for boilers over 20 years old, provided in each case they have longitudinal joints of butt and double-strap construction.

For old lap-joint boilers the following factors were adopted: 4¼ for boilers not over 5 years old; 4½ for boilers over 5, but not over 10 years old; 4¾ for boilers over 10, but not over 15 years old; and 5 for boilers over 15, but not over 20 years old. The code of the board was ordered printed. Until copies are ready for distribution information may be obtained by addressing N. J. State Board of Boiler Rules, care of the Department of Labor, State House, Trenton, N. J.

Oscar Otto

Oscar Otto, general superintendent of the South Philadelphia Machine Works of the Westinghouse Electric & Manufacturing Co., died on Monday, June 30, as a result of injuries received in an automobile accident on the previous Friday morning.

Mr. Otto was born in Manitowoc, Wis., Jan. 2, 1859. He finished an apprenticeship course as a machinist in the Manitowoc shops of the Chicago & Northwestern R.R. and after serving several years at various places in the State of Wisconsin, he accepted a position with the Northern Pacific Railroad Co. at Tacoma, Wash., going from there to the Oregon Short Line at Salt Lake City.

Prior to becoming general superintendent of the Westinghouse Machine Works at East Pittsburgh in 1909, he was connected with the Chicago & Northwestern R.R. as general superintendent of its Chicago shops. When the Westinghouse company opened its new plant at Essington, Penn., Mr. Otto supervised the installation of the machinery, and in February, 1918, he was permanently transferred to the new works, where he remained until his death.

He is survived by his widow, a daughter and three brothers.

The United States must supply part of the coal shortage of 40,000,000 tons in Europe, according to report by George S. Rice, Chief Mining Engineer of the Bureau of Mines, Department of the Interior. With a reduction in England from an eight- to a seven-hour day on June 16, and with the prospect of a six-hour day by the end of 1920, there will be a decreased output of 70,000,000 tons, leaving a possible margin of only 7,000,000 tons for export, if restrictions put in force during the war are removed. If the restrictions are continued, there will still be 40,000,000 tons to be supplied from the outside. France, Italy, Spain, Norway and Sweden have been largely dependent on England for coal, while the French mines, which produce 20,000,000 tons annually, were destroyed by the Germans. Italy in 1913 imported 10,000,000 tons from England. Mr. Rice reports that American companies are preparing to care for European needs. The figures of the Bureau of Mines show an immediate capacity in this country of 750,000,000 tons as against the largest single year's production in 1918, of 600,000,000 tons.

Patent rights have been taken out in France by P. L. Weston (No. 487,380) to cover the use of thin steel or iron belts on magnetized pulleys to transmit power. The magnetization of the pulleys is effected by windings lying in helicoidal slots on the surface of the pulleys. The thickness of the belt should not exceed about 0.06 times the diameter of the smallest pulley. With a steel belt of ⅛-in. thickness making contact over an arc of 145 deg. on a pulley of 10-in. diameter running at 4000 revolutions per minute, it is possible to transmit more than 200 hp. per inch width of belt. With a pulley of 50-in. diameter running at 800 revolutions per minute a belt of 1-in. width will transmit 1000 hp. Steel belts may be run at speeds of 18,000 ft. per min. so that this method of transmission is suitable for speed reduction with turbines.—*The Engineer* (London).

Personals

C. O. Mailloux, consulting electrical engineer, has returned to New York from a six months' trip in Europe.

H. W. Rand, formerly connected with the Chapman Valve Co., is now with the Ashton Valve Co., of Cambridge, Mass.

William J. Neville has been appointed Southern district sales manager of the Ashton Valve Co., of Boston, Mass., with offices in the Candler Building, Atlanta, Ga.

F. E. Ransley, formerly with the Doerman-Roehrer Co., of Cincinnati, has recently joined the selling force of the Dominion Asbestos and Rubber Corporation.

J. R. Kommer, who has been associated with the Federal Engineering Co. for the last fifteen years, has resigned to engage in waterworks consulting engineering exclusively.

H. H. Esselstyn has resigned as Commissioner of Public Works of Detroit, and will devote his entire time to the interests of his firm, Esselstyn, Murphy & Hanford, engineers and architects.

C. F. Miller, who has had charge of the Los Angeles office of the Dearborn Chemical Co. for many years, has resigned and assumed the management of the Independent Speedometer Repair Co., of Los Angeles.

J. J. Brown, formerly vice-president and general manager, has been elected president of the Wheeler Condenser and Engineering Co., Cartaret, N. J., succeeding Charles W. Wheeler, recently deceased. H. S. Brown of Boston has been elected vice-president.

Alex. B. Burns has been appointed manager of the stationary department of the Dearborn Chemical Co. on the Pacific Coast, with headquarters in Los Angeles. Mr. Burns has been with the Dearborn Co. on the coast for several years in the position of supervising engineer.

Charles C. Trump, formerly with the Humphrey Gas Pump Co., and the Stumpf Una-Flow Engine Co., Inc., of Syracuse, N. Y., is now connected with the Fuller-Lehigh Co., Fullerton, Penn., and the Fuller Engineering Co., of Allentown, Penn., as sales engineer in the New York City office, at 50 Church St.

F. V. Larkin, assistant general superintendent of the Harrisburg Pipe and Pipe Bending Co., and formerly assistant professor of mechanical engineering at Lehigh University, will return to Lehigh as professor of mechanical engineering on Sept. 1, to fill the chair vacated by the death of the late Prof. J. F. Klein, head of that department for many years.

Col. C. H. Crawford, until recently assistant superintendent of the Eddystone plant of the Baldwin Locomotive Works at Philadelphia, has been transferred to South America as its Brazilian manager, with offices in Rio de Janiero. Colonel Crawford will also act as representative of the American Association of Engineers in South America. His address will be Caisa Postal 350, Rio de Janeiro, Brazil.

Prof. Charles E. Lucke, of the School of Mechanical Engineering, Columbia University, has been honored for war services with the rank of Commander in Naval Reserves. A naval regulation has been broken in bestowing this rank on a civilian, the highest heretofore being that of lieutenant-commander to men from civil life. Professor Lucke trained thousands who served on submarine chasers.

Miscellaneous News

The American Association of Engineers is to open an office in New York City in charge of K. B. Knudson. The temporary address of the chapter will be 50 Church St., N. Y. C.

The Wellsburg Light and Power Co., of Wellsburg, W. Va., was destroyed by fire caused by a bolt of lightning during an electrical storm on July 15. Nobody was injured. The property loss is estimated at $100,000.

Members of the Technical and Mercantile Commission, representing the Czecho-Slovak republic, were recently received in Washington by George Otis Smith, director of the Geological Survey. This commission is touring the United States, investigating water power, methods of flood control, hydraulic fill dams and methods of irrigation. They will visit some of the largest hydro-electric plants while here.

Business Items

The American Pattern Works Co., of York, Penn., has taken over the entire business formerly conducted by the American Pattern Works.

The Wagner Electric Manufacturing Co., of St. Louis, announces the removal of its Philadelphia office, service station and warehouse to 1632-34 Sansom Street.

The Chicago Pneumatic Tool Co. announces the removal of its Minneapolis office from the Metropolitan Bank Building to Fifth Ave. and Fifth St. South, where a complete stock of the company's products will be maintained.

The Gould Supply Co., Inc., has taken over the business of the Gould Co., of Portland, Ore. The directors of the new company are William P. F. Ayer, president; Thomas Nickerson, vice president; G. A. Ricker, treasurer; Theodore W. Little and Carl T. Keller, all of whom are prominently connected with the Walworth Manufacturing Co.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7 95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2.35@2.80	$2.80@3.40
Philadelphia, gross tons	4 49@5.00	5.00@5.70
New York, gross tons	4.85@5.35	5.35@6.10
Alongside Boston (water coal), gross tons	6.35@7.05	6.85@7.50

Pocahontas and New River are quoted at $6.00 @6.25 per gross ton f.o.b. Norfolk and Newport News, Va., in response to export demand. There are practically no spot sales for coastwise shipments.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5 95	$7 80	Pea	5.10	6.85
Egg	6 15	8.00			
Stove	6.40	8.25	Buckwheat	3.40	5.15
			Rice	2 75	4 50
Chestnut	6 50	8.35	Barley	2.25	4.00

Bituminous

	Spot
South Fork (Best)	$2.95@3.25
Cambria (Best)	2.95@3.10
Cambria (Ordinary)	2.45@2 60
Clearfield (Best)	2.95@3 10
Clearfield (Ordinary)	2.45@2.60
Reynoldsville	2 50@2.75
Quemahoning	2 85@3.00
Somerset (Best)	2.85@3.00
Somerset (Poor)	2.35@2 60
Western Maryland	2.35@2.60
Fairmont	1.90@2.25
Latrobe	2 20@2.35
Greensburg	2.35@2.50
Westmoreland Z in.	2.75@2 90
Westmoreland run-of-mine	2.50@2.60

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

				Anthracite	
	Line	Tide		Line	Tide
Broken	$5.95	$7 80	Buckwheat	$3.40	$4.45
Egg	6 05	7 90	Rice	2.75	3 65
Stove	6 30	8 15	Boiler	2.50	3.50
Nut	6 40	8 25	Barley	2.25	3 15
Pea	5 00	6 60	Culm	1 25	2.15

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3.25
Mine-run	2 35@ 2.50	3.00
Screenings	1 85@ 2.20	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2 45	$2 75	$2.40
Black Creek and Cahaba	3.45	3.75	3.05
Jagger - Pratt Corona	2 85	3.05	2.45
Blacksmith	....	5.25	.....

Domestic quoations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3.95@$4.60
Corona	3 50
Jagger	3.50
Montevallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

	Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes, lump, egg, Nos. 1 and 2 nut	$2.75	....	....
Williamson County			
Prepared sizes, lump, egg, nut	$2.55	$2.55	$2 00@2 25
Mine-run	2.35	2.20	1.60@1.75
Screenings	2.20	2.05	1.15@1.30
3-in. lump	....	2.30	..
2-in. lump	....	....	1.75@1.90

Williamson-Franklin rate to St Louis is $1.07: other rates 92½c.

New Construction

PROPOSED WORK

Conn., Hartford—The Board of Contract & Supply will soon award the contract for supplying fire alarm cables, 750 ft. each of 15, 20, 30, 35, 40 and 50 lb. and 3000 ft. of 25 lb.

Conn., New Britain—The School Board will install a steam heating system in the 2 story, 80 x 272 ft. school which it plans to build on Bassett St. Total estimated cost, $200,000. C. C. Palmer, 272 Main St., Arch.

Conn., New Britain—The State Board of Education, Hartford, will receive bids until August 1, for the construction of a 2 story, 64 x 110 ft. school addition on Camp St. A steam heating system will be installed in same. Total estimated cost, $160,000. W. F. Brooks, Lewis and Gold St., Hartford, Arch.

Conn., New Britain—The State Board of Education will receive bids until August 1 for the construction of a 3 story, 80 x 113 ft. school. A modulation steam heating system will be installed. W. F. Brooks, Gold St., Hartford, Arch. Noted Feb. 4.

Conn., Putnam—The Manhasset Manufacturing Co. will soon award the contract for the construction of a 2 story, 100 x 200 ft. mill. A steam heating system will be installed in same. Total estimated cost, $125,000.

Conn., Warehouse Point—The Hartford County Home is preparing plans for repairing and building an addition to the home to include a heating plant. Total estimated cost, $200,000. Max J. Unkerbach, 162 Main St., New Britain, Arch.

N. Y., Bronx—The Board of Education, 500 Park Ave., New York City, will install a steam heating system in the 5 story, 230 x 280 ft. school which it plans to build to P. S. No. 62 on Liggett, South Bone and Fox Sts., Bronx Boro. Total estimated cost, $600,000. C. B. J. Snyder, Municipal Bldg., New York City, Arch.

N. Y., Brooklyn—The I. Candy Manufacturing Co., Inc., c/o W. T. McCarthy, Arch., 16 Court St., will soon receive bids for the construction of a 3 story candy factory. A steam heating system will be installed. Total estimated cost, $200,000.

N. Y., Canandaigua—The city plans to build an ice making plant. Estimated cost, $60,000. Address Pres. of Bd. Pub. Wks.

N. Y., Jamaica—The Essemen Realty Corporation, Fulton St., will construct a 5 story hotel by day labor. A steam heating system will be installed in same. Total estimated cost, $300,000. H. T. Jeffrey, Jr., Fulton St., Engr.

N. Y., Johnson City—R. C. Pratt plans to build an artificial ice making plant here and install necessary equipment. Total estimated cost, $175,000.

N. Y., Oswego—The Kirk Maher Co., 59 West Main St., Malone, has purchased the O'Keefe Bldg., here, and plans to remodel and build an addition to same for its own use. Ice making and refrigeration equipment will be installed. Total estimated cost, $25,000-$30,000.

N. Y., Pelham—The Board of Education will soon award the contract for the construction of a 2 story, 168 x 171 ft. school. A steam heating system will be installed. Total estimated cost, $115,000. Tooker & Marsh, 101 Park Ave., New York City. Arch. Noted May 13.

N. Y., Penn Yan—Nestle's Food Co., 130 William St., New York City, will install boilers in the milk station on Jacob Street which it plans to rebuild. Total estimated cost, $45,000.

Penn., Philadelphia—The Union National Bank, 3rd and Arch St., will receive bids in August for the construction of a 3 story, 60 x 75 ft. bank. A steam heating system will be installed in same. Total estimated cost, $100,000. J. T. Brugger, 505 Chestnut St., Arch.

Ky., Ashland—The Field Furniture Co. will soon receive bids for the construction of a 6 story, 30 x 145 ft., brick and concrete retail store and office building on Main St. A steam heating system will be installed in same. Total estimated cost, $275,000. F. L. Packard, Hayden Bldg., Columbus, O.

Ohio, Cleveland—The Aetna Rubber Co., 815 East 79th St., will build a 1 story, 29 x 37 ft. boiler room. Estimated cost, $6000.

Ohio, Cleveland—The Durable Tire & Rubber Co., 1115 Citizens Bldg., will install a steam heating system in the 3 story, 50 x 200 ft. factory which it plans to build on East 49th St. and Newburgh & South Shore Ry. Total estimated cost, $500,000. Engineer not selected.

Ohio, Cleveland—The McElrath Tire & Rubber Co., 620 Union Bldg., will install a steam heating system in the 2 story, 60 x 200 ft. factory and power plant which it plans to build on East 131st St. Total estimated cost, $80,000. Architect not selected.

Ohio, Cleveland—The Pauled Realty Co., Hippodrome Bldg., will install a steam heating system in the 5 story, 75 x 240 ft. theatre which it plans to build on East 105th St. and Euclid Ave. Total estimated cost, $400,000. Address Mr. Berne. Engineer not selected.

Ohio, Cleveland—The C. H. Snearner Furniture Co., 72 Wymore Ave., will install a steam heating system in the 4 story, 270 x 780 ft. commercial building which it plans to construct at 10022 Euclid Ave. Total estimated cost, $150,000. Engineer not selected.

Mich., Detroit—F. C. Brandt, 884 Michigan Ave., will soon award the contract for the construction of a 1 story, 60 x 100 ft. garage. A steam boiler for heating purposes will be installed in same. Total estimated cost, $15,000.

Mich., Detroit—The Packard Motor Car Co., East Grand Blvd., will soon award the contract for the construction of a 3 story, 196 x 201 ft. service station and garage on Antoine and Woodbridge St. A vacuum steam heating system, vacuum pumps and two boilers will be installed in same. A. Kahn, Marquette Bldg., Arch.

Mich., Wyandotte—B. C. Wetzel & Co., Arch., 2317 Dime Bank Bldg., Detroit, is preparing plans for the construction of a 2 story, theatre and office building. A steam heating system will be installed in same. Total estimated cost, $180,000. Owner's name withheld.

Ill., Chicago—The Argonne Hotel Co., c/o R. C. Harris, Arch., 190 North State St., will install a steam heating system in the 10 story, 130 x 170 ft hotel which it plans to build on Sheridan Road and Chase Ave. Total estimated cost, $900,000.

Wis., Kiel—The Kiel Woodenware Co. will soon award the contract for installing two 16 x 66 ft. high pressure boilers. Estimated cost, $15,000. Cahill & Douglas, 301 Grand Bldg., Milwaukee, Engr.

Wis., Sheboygan—The Ford Motor Co., Detroit, Mich., will install a steam heating system in the 5 story, 250 x 500 ft. factory which it plans to construct in Lake View Addition. Total estimated cost, $200,000. Architect not selected.

Minn., Chisholm—The Board of Education will install steam heating and mechanical ventilating systems in the 2 story, 100 x 120 ft. school which it plans to build. Total estimated cost, $200,000. W. T. Bray, Torrey Bldg., Duluth, Engr.

Minn., Gilbert—E. H. Berg, engr., Eveleth, will receive bids until August 1 for the construction of a 2 story, 100 x 110 ft. auditorium on Main St. for the city. A steam heating and mechanical ventilating system will be installed in same. Total estimated cost, $100,000.

Minn., Montevideo—B. O Bonn, city clk., will soon award the contract for extending the waterworks system. Equipment including a generator, 750 gal. per minute centrifugal pump with motor, switchboard, piping, etc., will be installed.

Minn., Nopeming—The St. Louis County Tuberculosis Commission will receive bids until August 18th for the construction of the three story, 40 x 320 ft. reinforced concrete building. A steam heating and mechanical ventilating system will be installed in same. Total estimated cost, $240,000. Halstead & Sullivan, Palladio Bldg., Duluth. Engr.

Minn., St. Paul—The Blue Mouse Theatre, 617 East 87th St., will soon award the contract for the construction of a 2 story, 50 x 150 ft. moving picture theatre on Hennepin Ave., between 7th and 8th St. A vapor heating system will be installed. Total estimated cost, $70,000. H. Lowrie, Paxton Blk., Omaha, Neb., Arch.

Minn., Virginia—The city will receive bids about September 1 for the construction of a 2 story, 190 x 275 ft., city hall and community building on 1st St., S. A steam heating and mechanical ventilating system will be installed. Total estimated cost, $282,000. A. W. Kerr & Co., Virginia, Engr.

Minn., Virginia—The Commissioners of St. Louis Co., Duluth, are having plans prepared by Croft Boerner, Arch., Palace Bldg., Minneapolis, for the construction of 2 story courthouse. A steam heating system will be installed in same. Total estimated cost, $250,000. Noted Apr. 29.

Kan., St. John—The city will receive bids until Aug. 6 for the installation of an electric light plant, and will install two 80 hp. boilers and 2 generators. Burns & McDonald, 400 Interstate Bldg., Kansas City, Mo., Engr. Noted May 20.

Neb., Omaha—The Sinclair Refining Co., 111 West Washington St., Chicago, Ill., plans to build a plant on 11th and Seward St., here, to include a boiler house. Total estimated cost, $250,000. W. T. Dinkins, 901-5 Woodmen of the World Bldg., Omaha, Local Mgr.

Mo., Kansas City—The House of the Good Shepherd plans to construct a power plant and install laundry equipment. Total estimated cost, $18,000.

Mo., Kansas City—Wolf Bros. Furnishing & Clothing Co. plans to install a refrigeration system. Estimated cost, $7000.

Mo., St. Joseph—The Roberts Cone Co., 709 North 3rd St., will install a steam heating system in the 5 story, 100 x 140 ft. factory which it plans to build. Total estimated cost, $200,000. Architect not selected.

Utah, Milville—The City will receive bids until August 4 for the construction of a complete electric distribution system for heat, light and power. Estimated cost, $30,000.

Cal., Los Angeles—Train & Williams, Arch., 225 Exchange Bldg., will soon receive bids for the construction of a 2 story, 92 x 100 ft. church on Olivera and Marchesault St., for the Methodist Episcopal Diocese, Wright & Callender Bldg. A hot air heating and ventilating system will be installed in same. Total estimated cost, $150,000.

Cal., Marysville—C. W. Burrell, Arch., First Trust Bldg., Oakland, will soon receive bids for the construction of a 4 story, 119 x 160 ft. reinforced concrete and brick hotel, on 5th and E St., for the Coyt Investment Co., 306 14th St. A steam heating system will be installed. Total estimated cost, $250,000.

Cal., Salinas—The Trustees of Salinas Union High School District have voted $250,000 bonds for the construction of a high school. A steam heating system will be installed. R. Kyckhoff, Watsonville, Arch.

Cal., San Francisco—The Pacific Orphan Asylum plans to construct an orphan asylum on Ocean Ave. A steam heating system will be installed in same. Total estimated cost, $500,000. A. H Jacobs, 110 Sutter St., Arch.

Cal., San Francisco—St. Francis Hospital, Bush St., will soon receive bids for the construction of a new central heating plant for the 6 story hospital which it plans to build. Total estimated cost, $250,000. A. I. Coffey, Humboldt Bank Bldg., Arch.

CONTRACTS AWARDED

Mass., Worcester—James Smith & Co., 89 Hope Ave., has awarded the contract for a 2 story, 60 x 212 ft. brick machine shop on Southbridge St., to E. J. Cross Co., 82 Foster St. An electrical power plant will be included in the project.

N. Y., Brooklyn—The Board of Education, 500 Park Ave., New York City, has awarded the contract for the construction of an addition to the school on McDougal St. and Rockaway Ave., to P. Cleary, 115 Marion St. A steam heating system will be installed. Total estimated cost, $208,700.

N. Y., Greensburg—The Board of Education has awarded the contract for the construction of a 2 story school to Oscawana Bldg. Co., 101 Park Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $90,000.

N. Y., Long Island City—The Globe Thread Co., Pierce Ave., has awarded the contract for the construction of a 50 x 141 ft. factory on Pierce and 7th Aves., to L. Barth & Sons, 32 Union Sq., New York City. A steam heating system will be installed. Total estimated cost, $100,000.

N. Y., New York—The Finkel Umbrella Frame Co., 2534 East 177th St., has awarded the contract for the construction of a 1 story, 100 x 200 ft. factory on Bush Ave. and 177th St., Bronx Boro., to I. Maifello, Williamsbridge. A steam heating system will be installed in same. Total estimated cost, $75,000.

N. Y., New York—The congregation of the Fifth Church of Christ Scientist, 42nd St., has awarded the contract for the construction of a 20 story, 145 x 179 x 200 ft. church on Madison Ave., between 43rd and 44th St., to W. J. Taylor, 7 East 42nd St. A steam heating system will be installed in same. Total estimated cost, $3,000,000.

N. Y., New York—The J. Eichler Brewing Co., 3582 3rd Ave., has awarded the contract for converting the 3 story, 64 x 84 ft. brewery at 169th St. and 3rd Ave. into an ice plant, to Hubener & Escher, 748 Melrose Ave. Estimated cost, $37,000.

N. Y., New York—The Philip Wurlitzer Co., 113 West 40th St., has awarded the contract for the construction of a 15 story, 50 x 85 ft. store and loft building at 119 West 41st St., to J. A. Zimmerman, 18 East 41st St. A steam heating system will be installed in same. Total estimated cost, $600,000. Mannicke & Franke, 25 East 26th St., Arch.

N. Y., New York—H. Phipps Estate, 737 5th Ave., has awarded the contract for the construction of a 14 story, 60 x 105 ft. office building on 46th St. and Madison Ave., to the Caldwell-Wingate Co., 281 4th Ave. A steam heating system will be installed in same. Total estimated cost, $500,000.

N. Y., Port Jervis—The Board of Education, 500 Park Ave., New York City, has awarded the contract for the construction of a 4 story school, to the Oscawana Bldg. Co., 101 Park Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $85,000.

N. Y., Salamanca—The Board of School Commissioners have awarded the contract for installing a steam heating and ventilating system in the Maple St. School, to the Johnson Heating Co., New York City, at $16,000. Noted July 22.

N. J., Plainfield—The Board of Education has awarded the contract for the construction of a 2½ story, 55 x 150 ft. school on Emerson Ave., to Bandandt & Boerinder, Plainfield. A steam heating system will be installed in same. Total estimated cost, $140,000. Noted July 1.

Ohio, Cleveland—The Sixth City Realty Co., Guardian Bldg., has awarded the contract for the construction of a 4 story, 167 x 370 ft. garage on East 6th and St. Clair Ave., to C. A. Garson, 6804 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $1,300,000.

Ohio, Cleveland—The Union Garage Co., 517 Sloan Bldg., has awarded the contract for the construction of a 2 story, 165 x 212 ft. garage on West St. Clair Ave., to C. A. Carson Co., 6408 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $400,000.

Mich., Ferndale—G. J. Hass, Arch., 1514 Kresge Bldg., Detroit, has awarded the contract for the construction of a 2 story, 138 x 143 ft. school on Woodward Ave., to W. H. Mueller, 1711 Ford Bldg., Detroit. Hot blast heating apparatus will be installed in same. Total estimated cost, $100,000.

Mich., Port Huron—The First National Exchange Bank has awarded the contract for the construction of a 2 story bank on Huron Ave. and Quay St., to Hoggson Bros., 485 5th Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $125,000.

Ill., Chicago—Straus & Schraus have awarded the contract for the construction of a 2 story, 65 x 120 ft. warehouse, at 105 West 35th St., to E. W. Sproul Co., 2001 West 35th St. A steam heating system will be installed. Total estimated cost, $120,000.

Wis., Port Washington—The city has awarded the contract for installing a generator and switchboard in the power house, to the General Electric Co., Milwaukee. Estimated cost, $30,000.

Kan., Topeka—The Masonic Bodies, 320 West 8th St., have awarded the contract for the construction of a 3 story, 140 x 265 ft. temple, to F. M. Spencer & Son, 215 Mulvane Bldg. A steam heating system will be installed in same. Total estimated cost, $500,000.

Ariz., Phoenix—The Arizona Packing Co. has awarded the contract for the construction of a 4 story, 200 x 250 ft. reinforced concrete building and a number of smaller buildings, using 2200 hp. and electric power, on Temple Rd., to the Packers' Architectural Engineering Co., Chicago. Estimated cost, $500,000.

Ont., Owen Sound—The town has awarded the contract for the construction of a hydro-electric power house, dam, etc., to W. M. Fletcher & Co., 151 Bloor St., W., Toronto. Estimated cost, $64,700.

Ont., Owen Sound—The City has awarded the contract for the construction of a hydro-electric plant, to the Canadian Westinghouse Co., Ltd., Hamilton. Electrical equipment, generators, transformers, etc., wil be installed in same. Total estimated cost, $90,000.

Employment "Opportunities"
JOBS and MEN—For Plant and Office: Technical, Executive, Operative and Selling: *See "SEARCHLIGHT"*

Equipment "Opportunities"
TO BUY, SELL, RENT and EXCHANGE—Used and Surplus New Equipment and Material—*See "SEARCHLIGHT"*

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OFFERED and WANTED—Contracts Capital, Plants, Properties, Franchises, Auctions—*See "SEARCHLIGHT"*

For "Opportunities" of every kind: "Think SEARCHLIGHT First!" See pages 88 to 99.

POWER

Volume 50 New York, August 5, 1919 *Number* 6

Candid Chats

The Chief Should Lead

IN ALMOST every human body there is a lazy streak, an inclination at times to half do a thing, to hit it a lick and give it a promise, and the monotony of routine power plant work induces it in the personnel from top to bottom. If the chief, dressed in clean cool clothes, sitting in his office behind a 16-inch fan, issues an order to his immediate junior to burn down, die out and clean the boilers of one part of the battery, then turns his attention to other matters, he is surely exercising his prerogative as boss, but will he get good results? He emphatically will not. But if he dons his unionalls, cap and work gloves, goes out into the boiler room to direct his men, now and then actually taking hold of the work with his own hands, the men will go at their tasks with the same spirit evinced by their leader, and the work will be quickly and easily performed.

If the chief furnishes the initiative, the brains and the will power, the men will become imbued with his spirit and the work will swing along smoothly. Then the chief may slip away and give his attention to something else. But it is well to show up occasionally during the progress of the work, take hold of some of it and give it another push—not in a nagging way but by doing something that the men must do, such as trying the turbining of a few tubes with a few words to the fellow who is doing it—this sort of thing does a lot toward making the men feel that the chief is one of their kind.

Now, perhaps some will feel that their time is too valuable to waste in such a manner, using the idea that a good boss gets the others to do all the work. That does sound well, but it does not always work, and if plant morale amounts to anything, then leadership is the best developer of it. Chiefs who want to be good leaders of their men ought to size up about as follows:

Have a complete knowledge of all the work to be undertaken and the conviction of past experience. The men should never for a minute get the idea that their chief doesn't know his job.

Have a good knowledge of the men, their likes and dislikes, their interests and welfare.

A disposition to harmonize, for friction among men tends to delay the work and causes general discontent.

Always be open-minded enough to consider suggestions from even the humblest coal passer or engine wiper.

These suggestions, of course, are not necessarily questions of plant management, but your men will be favorably impressed if their ideas and suggestions on the minor things that come up every day are heeded. Men like to feel that they can use their heads to give you a pointer once in a while.

Intimacy with your men is not as detrimental as is the habit of aloofness. It is possible for a leader to make each one of his men feel as though he were a personal friend and still have him respect the position as chief. A word of praise now and then also helps wonderfully.

Reprimand your men when it is needed, but in such a way that no scar is left. If a man does not do as you tell him, or do it in the right way, ask yourself if by any chance he could have misunderstood you.

But if reprimand is needed, make it to the point, positive, and without heat, then give him a job that requires unusual responsibility and let him climb back into your good graces.

Contributed by Charles H. Willey

Making Three Boilers Do the Work of Five

By J. J. SPANGLER

By revamping a plant short of engine and boiler capacity, due to inefficient conditions, three boilers were made to do the work that five could scarcely handle, and a saving in coal estimated at 7000 tons per year was effected.

DURING the summer run of 1918 the Peerless Portland Cement Co., of Union City, Mich., had a hard time getting through its running season, which generally opens in March and continues to the end of the year. Most of the trouble was due to inefficient conditions in the power plant, which resulted in numerous shutdowns aggregating a total of 42 days during the season and causing a serious financial loss, as the capacity of the plant was 1600 bbl. of cement per day.

In the first place the load on the engines was so heavy that they could not handle it when running noncondensing. Condensers had been installed but were of the steam-driven, jet type, located several hundred feet from the power plant and 36 ft. below on the river bank. The condensing equipment was in bad shape and broke down frequently. At such times it was necessary to remove some of the load so that the engines could maintain normal speed. When the condensers were in service, the vacuum at the engines did not exceed 18 in. The live-steam lines leading to the condensers were uncovered, causing a great loss of steam, and this when the plant was short of boiler power to meet the demands under the inefficient conditions prevailing.

CONTRACTING ENGINEER CALLED IN

The need of engineering advice was recognized by the management. The first conference with a firm of consulting engineers resulted in a decision to install a barometric condenser. This, however, would not entirely relieve the situation, as additional boiler capacity would be needed. About this time H. J. Gebhardt, contracting engineer, of Chicago, was called into consultation by the management. After becoming familiar with the conditions he decided that changes in the condensing equipment that would eliminate the steam consumption at the river condenser house and improve the vacuum, and a better water supply from the boilers and a thorough overhauling of the engine room, would put the plant in such condition that it could easily care for the present demands without addition to the engine or boiler capacities. By Jan. 23 of this year a supervising engineer was on the job to carry out the remodeling considered necessary. It was desired to have the plant in operation by Mar. 1 if possible.

The first step was to tear out the jet condensers at the river and install near the plant a surface condenser having 3000 sq.ft. of surface. The next was to dig a receiving well at the river bank for the circulating water and at this point to install a centrifugal pump directly connected to a 30-hp. motor to furnish water for the condenser and the mill supply. The saving effected by the installation of this pumping unit will be realized when it is stated that it is to do the work previously cared for by a 13½ x 20 x 18-in. jet condensing outfit, another jet condenser with dimensions of 28 x 14 x 19¾ in. and two direct-acting steam pumps on the mill supply, one a 10 x 6 x 12-in. simplex, and the other a 14 x 8 x 14-in. duplex pump, all being steam-driven, while the present pump is motor-driven.

CHANGES IN EXHAUST-STEAM LINES

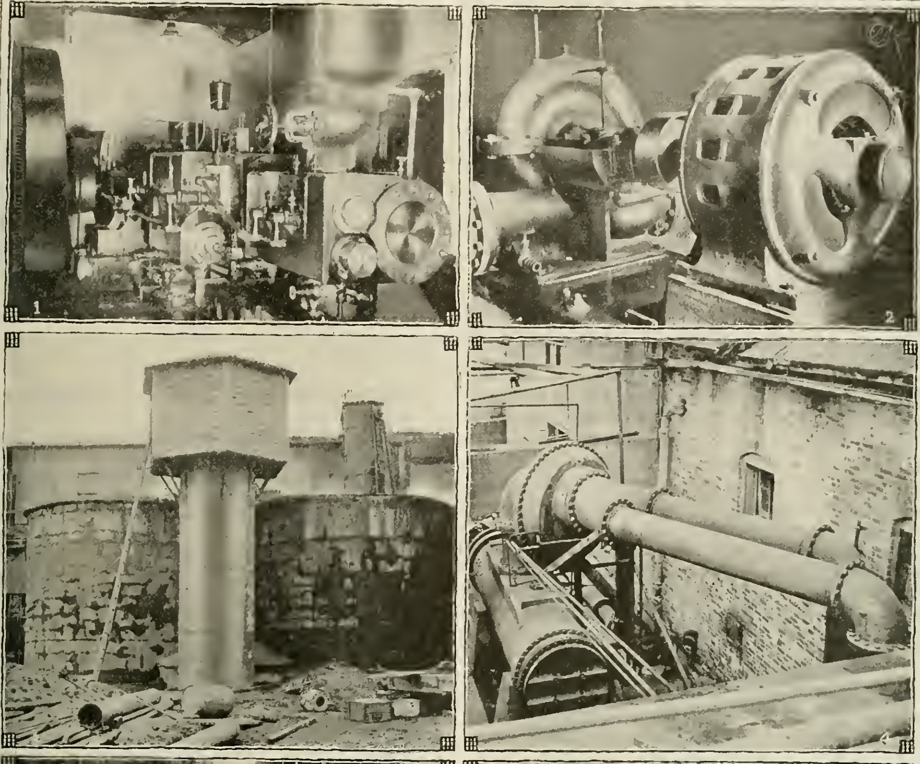
From the plant to the old condensing equipment there were two exhaust steam lines, one 10 in. in diameter and the other 15 in. Near the engine room these lines were severed and the plant ends of them used to convey the exhaust steam from the engines to the new surface condenser. The river ends of the lines were used to convey the circulating water from the pump at the river to the condenser and back again toward the river. The 10-in. line was connected to the pump discharge and the 15-in. line used as an overflow for the cooling water from the condenser. Between the condenser and the pumphouse at the river, a hotwell was excavated and the return water from the condenser discharged into it, the end of the pipe being submerged in the well so as to effect a water seal. As the well is about 25 ft. below the overflow at the condenser, the head on the circulating pump is reduced 10.85 lb., thus decreasing the current consumption of the motor driving the pump. From the hotwell the water overflows into another section of the 15-in. pipe and is discharged into the river downstream from the pump section.

At the side of the river where the pump is located, the water is relatively low and in midsummer is apt to go dry. To insure a constant supply a canal of sheet piling was driven from the receiving well to the main channel of the river and the interior excavated to make an open channel for the water. At the entrance to the receiving well two screens have been provided, one of 1-in. mesh and the other of ½-in. mesh. Either can be removed for cleaning while the other remains in service.

WATER-SOFTENING PLANT INSTALLED

An analysis of the river water used for boiler-feed purposes showed that it contained between 17 and 19 deg. of hardness. In the past the boilers had scaled badly and there had been no end of trouble from tubes burning out and boiler-washing expense. Due to a number of small steam-driven units in various locations about the mill that exhausted to atmosphere, the amount of makeup water needed was a considerable proportion of the boiler feed even after the surface condenser was installed. Consequently, a water-softening plant was installed to care for the make-up. It was designed to reduce the hardness to 4 deg., although at times due to variations in the quantity of water and improper proportions of chemical, 8 deg. of hardness, or in other words, 8 gr. of scale-forming matter per gallon remained in the water. Even with this degree of softening there was a great improvement in operating conditions in the boiler room.

The boilers had been equipped with inclined-grate stokers arranged for the circulation of cooling water. Connections were made into the upper and lower drums of the Stirling boilers in the plant, and circulation de-



FIGS. 1 TO 6. SHOWING SOME OF THE CHANGES MADE IN THE PLANT OF THE PEERLESS PORTLAND CEMENT COMPANY

Fig. 1—Tandem compound cylinders placed on frame of simple engine. Fig. 2—Circulating pump at river. Fig. 3—Water-softening system and settling tanks. Fig. 4—New surface condenser installed adjacent to engine room. Fig. 5—Motor-driven triplex pump replacing direct-acting boiler-feed pump. Fig. 6—Extending intake to main channel of river.

pended on gravity. Owing to the formation of scale and intermittent operation, the cooling system did not prove effective, so that numerous grates were burned out. A great improvement was effected by installing a positive circulating system. The steam coils were removed from an old feed-water heater and the shell placed on the pumproom roof above the present feed-water heaters. Water from two big concrete settling tanks, forming part of the softener, was pumped to the grates and discharged to the open tank above the heater. The discharge to the tank was open so that from the boiler-room door the fireman could see that circulation through the grate was maintained. Under float control the water in the open tank flows by gravity to the feed-water heater.

All the condensate from the condenser is pumped into the settling tanks of the softener to raise the temperature to facilitate precipitation and in order that the boiler-feed water might be uniformly mixed. In passing through the grate the temperature of the circulating water is raised to 180 deg. F., so that the heater has comparatively little work to raise the temperature of the water to the usual 210 deg. On this account, even after eliminating the steam-driven equipment at the river, there was still more exhaust steam available than was required by the heater. Consequently, the steam-driven boiler-feed pump was replaced by a motor-driven triplex plunger pump, which in conjunction with the motor-driven pump at the river, takes current from the main generating units and thus uses steam at a better rate than did the direct-acting pumps formerly in use.

Changes Made in Engine Room

In the engine room there was need for considerable remodeling. A 22 x 36-in. piston-valve simple engine, directly connected to a 300-kw. generator, caused a great deal of trouble, as it was so heavily loaded that with a slight variation in steam pressure it would lose speed and in some cases drop the load. Besides it was extravagant in the use of steam, an unusually long cutoff being necessary to carry the load. The remedy was to remove the cylinder and attach to the same frame tandem-compound cylinders, measuring 18 x 34 x 36 in. The result was a more economical unit that would easily handle the load.

A tandem compound engine 18 x 30 x 42-in., driving the grinding mills through rope transmission, was also in bad shape. It had been running almost constantly for 16 years night and day, and because of so much dust and grit in the mill, the governor had become badly worn and sluggish. It would not respond quickly to variations in steam pressure or load, so that the speed regulation was bad. A new governor was installed, the valves reset and the engine given a general overhauling, with the result that it is now giving efficient service.

A third unit, consisting of a cross-compound Corliss, 18 x 36 x 48 in., operating at a speed of 97 r.p.m. and belted to a 400-kw. generator, had wrecked the high-pressure cylinder. This was replaced, and a general overhauling made the unit as good as new.

Boiler-Room Equipment

In the boiler room the equipment consisted of five boilers, one a horizontal Page-Burton sectional water-tube boiler rated at 350-hp., two 350-hp. and two 220-hp. Stirling boilers. All were equipped with the inclined-grate stokers previously mentioned. Feed-water regulators were installed and in the way of instruments, draft gages and a CO_2 recording outfit were provided. Two of the 350-hp. boilers were equipped with soot blowers, and later on it is the intention to install blowers in the other boilers. The coal-handling equipment consists of a bucket elevator and screw conveyors at right angles to each boiler. A steam-jet vacuum conveyor takes care of the ash.

After the changes enumerated had been made, it was found that the plant could be operated with three boilers as compared to the five previously used and an extra boiler contemplated. The greater part of the work was completed and the plant started up by Mar. 2. From results obtained, it has been estimated roughly that the saving in coal per season will amount to about 7000 tons, or, in round figures, a saving of about $30,000 per year. The plant is now in excellent condition and is good for many years of efficient service.

Steam Whistle as Legal Nuisance

Whether the owner of a steam-power plant is liable for injury caused by a horse taking fright on the blowing of a whistle at the plant must be determined according to whether any unreasonable noise has been caused under negligent circumstances. This is the test laid down by the Arkansas Supreme Court in the case of Daugherty vs. Southern Cotton Oil Co., 211 Southwestern Reporter, 179, in which it was decided that defendant was not liable for such an accident. The court makes this summary of the law on this point:

> The use of a steam whistle in a manufacturing establishment is not a nuisance in itself, but it may be so used as to become such. In the application of this principle it has been frequently held that, although it is lawful for a manufacturing establishment to maintain a steam whistle, that whistle must be used with ordinary care and due regard to the rights of others, and if, by the negligent use thereof, horses are frightened and caused to run away and inflict injury, the owner of the establishment is liable for the resultant damages. On the other hand, it may be said that the traveling public is entitled to make free use of the streets of the city, and that an adjoining property owner has no right to so use his property as unreasonably to interfere with the public enjoyment of this right. Still the doctrine is settled that it is not negligence in itself to own and operate near a public highway or street, a gin or other industrial plant in the necessary and reasonable operation of which loud noises are produced. . . .
>
> The use of the steam whistle in giving signals and for other necessary purposes in connection with operation of the plant becomes wrongful only when its use is attended with negligence. It is true that the horse became frightened at the sound of the steam whistle and ran away, throwing the occupants of the buggy with great violence upon a concrete sidewalk, and that he was a gentle and well-broken horse; but it will not do to say that, under these circumstances, defendant was guilty of negligence. If we should so hold that, because it was possible that a gentle and well-broken horse should become frightened at the noise of a steam whistle of the kind ordinarily in use when used in an ordinary manner, the effect of such holding would tend to prevent gins and other plants using steam from establishing and operating their plants in such places and thereby greatly retard the progress and development of the country.

But it is to be inferred from the opinion that liability will attach should a whistle be sounded under such unreasonable circumstances that the person blowing it should know of the likelihood of horses being driven nearby taking fright, as where an engineer sees a team being driven by his plant and yet gives a sudden and loud blast which prudence should prevent him from doing until the team has passed.

Installation and Use of Air Chambers

By H. D. FISHER

Pump makers and users seem pretty well agreed that reciprocating pumps should be provided with air chambers to ease the shocks due to the starting and stopping of the column of water in the pipe line with each stroke of the plungers, but in putting this into practice there seems to be no very general recognition of the most effective arrangement and not much provision for maintaining enough air in them to make them serve their purpose.

THE function of an air chamber is to provide an elastic cushion to absorb the energy of the column of water leaving the pump, which has attained a velocity higher than the average during the middle of the piston stroke, and to feed out this energy again to maintain the velocity of the water in the pipe beyond the air chamber more nearly uniform during the period at the end of the stroke when the piston stops. To accomplish this most effectively, the air chamber should be arranged so that the moving stream of water flows directly into its lower end or is so guided into it that little energy will be lost by the eddying and disturbed flow of water making a sharp, unguided turn or attempting to return upon itself. It must not be lost sight of that it is just as much the function of the air chamber to feed out the energy absorbed and thus maintain a reasonably uniform flow as it is to absorb the shock in the first place. A water gage should always be installed so that it is known there is air in the air chamber.

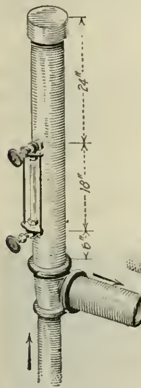


FIG. 1. AIR CHAMBER

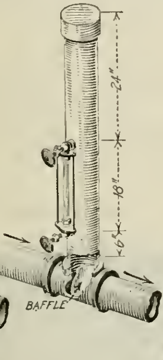


FIG. 2. BAFFLE IN TEE

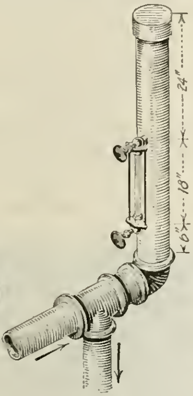


FIG. 3. ANOTHER ARRANGEMENT

The illustrations show arrangements suitable to various locations, all of which will work satisfactorily, as has been proved in many installations. Of these, Fig. 1, where a riser turns into a horizontal run is probably the most desirable as it requires fewest fittings, these are all standard and in it the air column meets the flow most directly. Equally effective is that shown in Fig. 2, for use in horizontal runs. Many similar air chambers have been condemned because the baffle to direct the stream upward has been omitted. The baffle need not fit water-tight, but should fit reasonably close and be firmly fastened by welding or screwed clips, as in long lines the pressure against it is considerable.

Arrangements shown in Figs. 3 and 4, where a horizontal line turns sideways or downward, are also good, but that shown in Fig. 5 should not be installed except where there is a supply of compressed air available for filling.

The best results are obtained by making the air chamber of the same size pipe as the feed line and obtaining the necessary volume by increasing its length. If it is made either larger or smaller, there will be an abrupt change of velocity in the water entering or leaving the air chamber, with a corresponding loss of energy and efficiency. For the average plant the dimensions shown on the sketches are ample, but for very long lines, such as occur in pumping plants, etc., the height should be considerably increased.

But no matter how well located the air chamber is, it must contain sufficient air to provide a cushion, and in plants where no supply of compressed air at or above boiler pressure is available this is often difficult to maintain, as the solvent power of water for air increases directly with the pressure. For instance, at 150 lb. it will dissolve eleven times what it would in an open tank, and any air in the air chamber rapidly disappears. Under such conditions it is customary to use the feed pump as a compressor, where the suction pressure is not too high, opening the water-cylinder draincock on the suction stroke, or with an open heater lowering the water level during a light-load period so that the pump sucks some air.

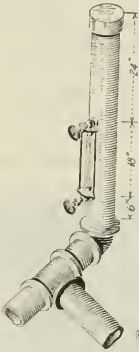


FIG. 4. A GOOD ARRANGEMENT

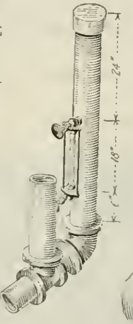


FIG. 5. REQUIRES COMPRESSED AIR

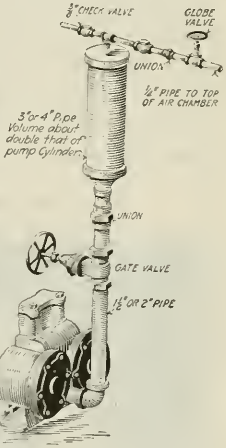

⅜" CHECK VALVE
GLOBE VALVE
UNION
¼" PIPE TO TOP OF AIR CHAMBER
3" or 4" Pipe Volume about double that of pump Cylinder
UNION
GATE VALVE
1½" OR 2" PIPE
FEED PUMP

FIG. 6. HOW AIR IS SUPPLIED

A slightly more elaborate but effective arrangement, devised by Mr. Merriam, master mechanic at the Methuen Co., Methuen, Mass., is shown in Fig. 6. This also has the advantage that by throttling the valve it can be arranged to deliver just the quantity of air required and will work indefinitely without attention. By means of the unions it could be quickly removed for the purpose of making repairs to the pump or for packing pistons.

It is in only very long lines, where the weight of the moving column of water is such as to cause severe shocks or where pumps are in very bad condition and give a similar effect, due to reversed flow, that the need of air chambers is forcibly impressed on the operating engineer. They are, however, advisable under all circumstances and particularly where it is desired to measure flow by means of orifice, venturi or pitot-tube meters, as, by reason of the natural laws on which they work, pulsating flow will cause all of them to read high by varying amounts.

In all these meters the pressure difference which operates the recorder mechanism is proportional to the square of the rate of flow; that is, if the flow is doubled, the pressure difference operating the recorder increases four times. Owing to inertia of the meter mechanism and friction and inertia of the water in the recorder connecting pipes, the meter acts like a throttled gage and shows a fairly steady reading, this reading corresponding to the average of all the differences of pressure corresponding to the flow at each instant.

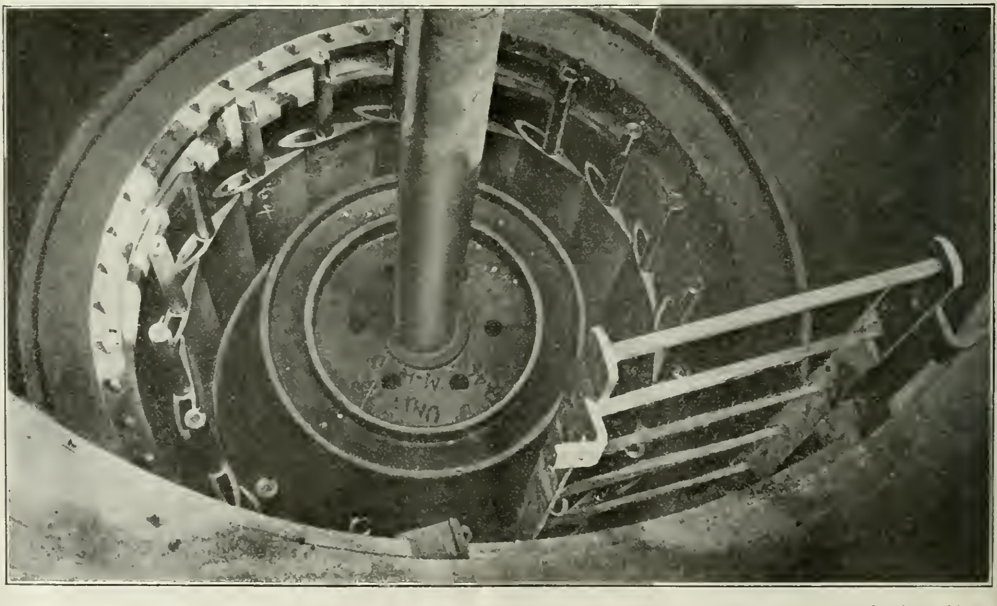
But in a situation of this kind the higher rates of flow will have a great deal more than their proper share of influence on the averages as what is being averaged is not the flows but the pressure difference produced by them, which increases very much faster than the rate of flow. For example, if for half the time the flow were 5 ft. per sec. producing a pressure difference of 2 in. of mercury and half the time 10 ft. per sec. with a pressure difference of 8 in. of mercury, then the average flow during the period would be 7.5 ft. per sec., but the average pressure difference acting on the recorder would be 5 in. of mercury, which would give a reading of 5 ft. per sec., or about 5.5 per cent. high. If the flow were nothing half the time and 15 ft. per sec. half the time, giving the same average of 7.5, the average pressure difference would be 9 in. of mercury and the recorder would read 10.6 ft. per sec., or 41.4 per cent. high.

Thus it will be seen that the wider the variation in rate of flow the greater will be the error of the rate of flow meter unless proper air chambers are provided to reduce the pulsations and produce a reasonably steady flow.

Reducing the fluctuations in flow by means of an air chamber is the only correct solution for problems of this kind. While experiments could be made and the meters calibrated to correspond to the conditions found, yet if the load or particularly the condition of the pump and valves changed, so that, for example, there was a slightly reversed flow, due to a defective valve on one pump stroke, this effect and its correction, which may very properly be called its pulsation factor, would be entirely different and require recalibration of the meter, while if proper air chambers are installed and it is seen that these are kept filled with air, the original meter calibration may be relied on and may be checked against steady flow at any time.

Early in September, patrons of the Kansas City Light and Power Company will receive their first current from a new $7,000,000 power plant which is now being completed in that city. It will be equipped with three 33,000-hp. turbo-generators.

Looking Down on the Wicker Gates of the Turbine of an Exciter Unit



The young man starting in a hydro-electric plant, and the engineer who desires to become acquainted with hydraulic turbines, like first of all to know, "how the thing looks inside." This picture so well shows the arrangement of the wicker gates of a hydraulic turbine that such men will be pleased to see it.

Needed Information on Refrigerants

By John E. Starr*

The consulting or designing engineer is as a rule a busy man. He is not expected in every case to go back to original and basic figures in thermodynamics. As a rule he goes no further than well-established tables of the properties of the working fluid he is dealing with.

No man in figuring a steam problem would, as a rule, spend the time and thought necessary to traverse plowed ground and figure, *a priora*, the latent heat, volume, heat of liquid, etc., of steam, nor would it be expected of him. He would pick up his Marks and Davis, Peabody or Kent or some other standard book containing steam tables and find at a glance, already figured for him, the required data.

The engineer has a right to rely on these tabulations. A reliance on standard tables in the case of steam is perhaps absolutely safe, but unfortunately, in the case of many other common fluids it is as yet far from safe.

Since the valuable contributions of Goodenough and Mosher, Keyes and Brownlee and the United States Bureau of Standards, and through the efforts of the American Society of Refrigerating Engineers, the figures on the physical properties of ammonia are now available, and there is so little difference in the tabulated figures that almost any reasonably up-to-date set of them will agree close enough for practical estimate or design.

This is not the case with many other fluids in daily use. Tabulations on chloride of methyl are published showing some variations. Sulphur-dioxide tabulation is fairly good, although Le Doux, Zeumer, and Denton and Jacobus differ slightly all the way through, although their little differences are more academic than practical.

Probably not more than four people in this country have the full data as to chloride of ethyl (a commonly used fluid) and these are from figures produced by Dr. K. Ohnes, of Leyden University, based on the results of work by Regnault and Gierre, and the previous calculations of Claperyon, Clausius and Selon and translated and extended by Starr.

The growing importance of CO_2, or carbon dioxide, as a fluid used in refrigeration brings the attention sharply to the subject. Designs make a calculation based on the tables authoritatively published vary so greatly that their use is extremely embarrassing.

Suppose a man is figuring on this fluid (CO_2) and picks up a table of Professor Schroeter such as is widely published in a half dozen compends and numberless catalogs of refrigerating machinery. For the sake of giving a definite example, say, he is figuring from —4 deg. F. to +77 deg. F., a common range of temperature between temperature sought and cooling water available.

He will find for —4 deg. a pressure of 292 lb. abs., a latent heat of 126.79 B.t.u., a volume of 0.3065 cu.ft. per lb. (3.265 lb. per cu.ft.) and heat of the liquid below 32 deg. of 26.91. For 77 deg. he finds a pressure of 938 lb. and a heat of liquid of 57.06 above 32 deg. F.

Relying on this, he figures the heat of liquid as a total of —26.91 + 57.06, or 83.97. He then quickly solves $\frac{200}{126.79 - 83.97}$ and find he needs 4.67 lb. to the ton ex. cylinder heat and clearance 4.67 × 0.3065 equals 1.43155 cu.ft. per ton for displacement without practical allowances.

Suppose he had picked up Mollier or the result of a combination of Amagat and Mollier, widely published and notably repeated by Macintyre, p. 102, 1914: He would first find the pressures were given 288.7 lb. and 930 lb. instead of 292 lb. and 968 lb. This would not matter much as the mean pressure would come out pretty close. But he finds for the heat of vaporazation 118.87 B.t.u. heat of liquid — 17.87 for —4 deg. F. and +33.19 for 77 deg. and a volume of 0.313 cu.ft. per pound.

The final calculation is: $\frac{200}{118.87 - (+ 17.87 + 33.19}$ × 0.313 = 0.92335 cu.ft. per ton without allowance, instead of 1.42829.

The first calculation therefore (based on Schroeter) calls for a compressor 54.6 per cent. larger at the same speed than a compressor called for by Amagat and Mollier. At other ranges of temperature similar discrepancies occur, some smaller and some larger. But 54.6 per cent. is altogether too great for comfort. An examination of the figures shows the horsepower per pound to be only slightly different. But the horsepower per ton is of course different as in one case it would figure: 1.42829 × m.e.p. × 144 = ft.-lb. per ton, and in the other, 0.92335 × m.e.p. × 144 = ft.lb. per ton. There is still a difference of 54.6 per cent. in horsepower per ton.

Capacity might be remedied by change of speed, but horsepower per ton could not be if the wrong table were used.

Amagat and Mollier are perhaps nearer right, but it is not the purpose here to discuss the correctness of the tables, but only to show that there is a wide divergence. In either case, if the wrong tabulation was adopted, a contract would fail on horsepower per ton, and perhaps capacity might fail because arrangements made for speed might have been unalterable. In any event results as to capacity at a given speed would fail if the wrong table was taken.

There is also lacking in the case of CO_2 complete tabulation of the superheated gas at ordinary condenser temperatures. In this country the cooling water is on the average much higher in temperature than in Europe; so high, in fact, as to give condensing temperatures rather close to the critical temperature of CO_2, variously stated to be from 88.43 deg. F. to 88.6 deg. F.

We have tables of the superheat of ammonia carefully worked out and mathematically correct, but little used practically, because the critical temperature of ammonia (273.2 deg. F.) is so far above any normal condenser conditions that it seldom enters into calculations.

With CO_2, however, 88.6 deg. has to be reckoned with and there are no practical data that can be depended upon after we reach this plane in the condenser.

Mention is made in a vague way of the falling off of refrigerating work with CO_2 or the increase of horsepower per ton when the critical temperature in the condenser is passed, but little of a practical or even theoretical nature has been adduced.

Someone, perhaps the United States Bureau of Standards, should settle this matter for all time.

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Cores and Coils for Transformers—I

By ARTHUR PALME
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The structural details of various types of transformer cores are considered. A second article will describe the various windings used in modern transformer practice.

ARTHUR PALME

An ELECTRICAL transformer is a stationary piece of apparatus designed to change the electric pressure or voltage of a circuit. This change may be either an increase or a decrease of voltage (step-up or step-down transformer). The change is made by electromagnetic induction, which necessitates a steadily fluctuating magnetic field, and is therefore possible on alternating-current circuits only. The reason for the use of a transformer lies in the fact that it is much more economical to transmit electric power over a long distance at a higher voltage than electric generators can produce.

It may be considered the upper limit to insulate a generator for 13,200 volts operating voltage. Yet, with this voltage only a relatively small amount of power can be transmitted but a few miles without undue losses. Raising the pressure makes possible the covering of long distances and the transmission of large amounts of energy with reasonable cross-sections of conductors. Using a voltage of more than 100,000 volts enables economical transmission of many thousand horsepower over more than 300 miles. Of course at the other end of the transmission line one or more stepdown transformers have to be installed in order to reduce the voltage again to an amount that can be safely taken care of in motors or other power consuming devices (see Fig. 1). At first glance it would appear a wasteful undertaking to employ a double transformation. However, a transformer is a stationary machine with no moving parts, and requires very little attention. Furthermore, the efficiency of a modern transformer is, depending upon its size, usually from 96 to 99 per cent., so that it causes very small losses. Transformers can be built absolutely weatherproof for unprotected outdoor installation; it is therefore not essential to provide space for these machines within the power house or substation.

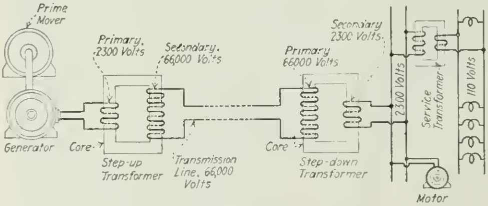
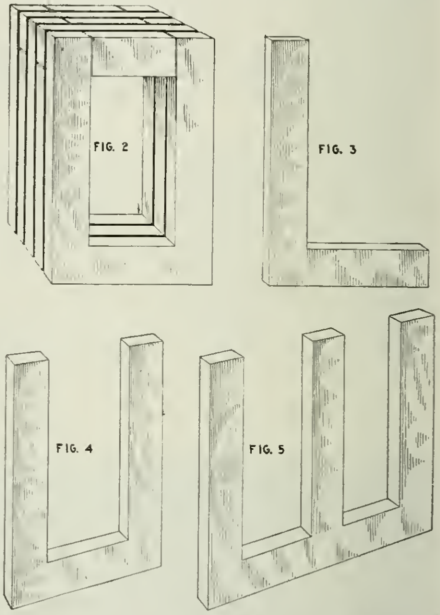


FIG. 1. DIAGRAM OF CONNECTIONS FOR ELECTRICAL-POWER TRANSMISSION

Every transformer consists mainly of two distinct electrical windings wound on an iron core. The two windings, called primary and secondary, are carefully insulated electrically from each other and the core, but are coupled magnetically through the iron core.

In order to obtain a transformation as efficient as possible, it is necessary that, as nearly as may be, all the magnetic flux set up by the primary windings shall enter the secondary windings. In other words, it is essential to avoid magnetic leakage. Aside from the number shape and the arrangement of the coils, the magnetic leakage is largely controlled by the iron core of a transformer.



FIGS. 2 TO 5. CORE ASSEMBLY AND CORE LAMINATIONS; THICKNESS GREATLY ENLARGED

Every winding that carries alternating current produces a fluctuating magnetic field, the main axis of which is parallel to the axis of the winding. In any metallic mass that is brought within this field will be set up so-called eddy currents, which will quickly cause a heating of this metallic body. This fact can be easily demonstrated by holding a pair of pliers or any other substantial piece of metal within a small coil connected to an alternating-current supply. The metal will soon get so hot as to burn the hand. For this reason iron cores used on transformers cannot be made up of a solid piece of iron, but must be subdivided in such small parts as to make the eddy currents negligible. It is general practice to build up transformer cores from thin sheet-steel pieces punched or sheared in the proper shape. As the frequency of the alternating current determines the value of eddy currents, the thickness of the core punchings is made approximately 14 mils for all 60-cycle transformers, and 25 mils for 25-cycle cores (0.014 in. and 0.025 in. respectively). For special transformers used on high-frequency work, such as radio-transformers, much thinner sheets, down to a few mils, must be used, to prevent undue heating of the core.

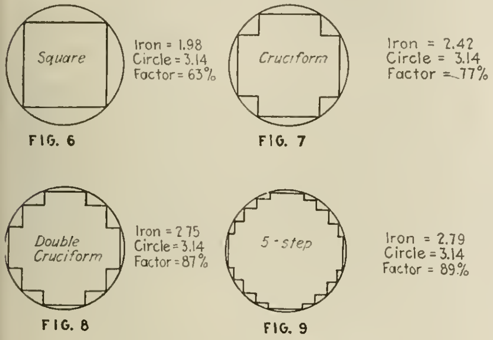


FIG. 6 FIG. 7 FIG. 8 FIG. 9

FIGS. 6 TO 9. CORE CROSS-SECTIONS

The individual sheets making up the whole core must be electrically insulated from each other. This used to be done by stacking the steel sheets alternately with sheets of very thin tissue paper. At present, however, it is general practice to coat every punching on one side with a thin film of quick-drying special lacquer. The punchings are stacked so as to form the core and clamped together with bolts. Great pressure has to be used for this clamping, because loose core punchings will cause an objectionable humming noise, combined with more or less violent vibrations. To entirely prevent the humming does not seem to be possible; it is therefore an easy test to determine whether a transformer is "alive" by simply holding the ear against the tank; if a slight hum is heard, the transformer is sure to be in operation.

The necessary subdivision of the transformer core replaces part of the steel in the volume of the core with insulation. This so-called iron factor, which depends upon the thickness of the iron and the lacquer, reduces the effective area of the core by about 10 per cent. The factor is essential for the exact calculation of a transformer.

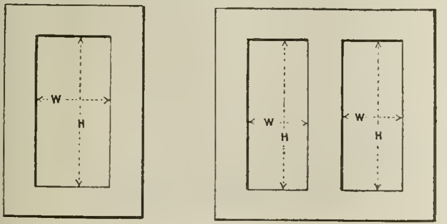


FIG. 10. CORE-WINDOW DIMENSIONS

The losses in a transformer are composed of hysteresis losses, copper losses, and eddy-current losses. To keep these as low as possible is the only way to obtain the highest operating efficiency. While the copper and eddy-current losses depend chiefly upon the resistance and the arrangement of the windings and core, hysteresis losses are due to the necessary power required to produce and to maintain the alternating magnetic flux. It is assumed, hypothetically, that any piece of iron consists of countless magnetized iron molecules arranged in such an irregular way as to be, as a whole, without distinct magnetic polarity. When such a piece of iron is brought within a direct-current field, all its molecules will assume immediately a uniform position, having all North ends turned one way and all South ends the opposite way. Thus the whole piece of iron will show a distinct polarity. The straightening of the molecules is assumed to cause a certain amount of molecular friction, which takes a certain amount of electrical energy. It will be seen from this that if such a piece of iron is brought within an alternating-current field, all its molecules will have to undergo constant turning from one position to another one, 180 deg. apart. The speed of this magnetizing and remagnetizing depends on the frequency of the alternating current and amounts to 120 times per second for a 60-cycle circuit. This causes a considerable and constant molecular friction, which requires what is called the magnetizing current of a transformer, and represents the hysteresis loss. The amount of this loss is determined by four factors; the frequency, the volume of iron in the core, the density of the magnetic lines and the magnetic quality of the iron used. The first factor is decided by the current supply; the next two factors must be determined by calculation; the fourth factor requires research work of a magnetic-metallurgical nature. Such work has been done and has resulted in a number of alloy-steels which give very low losses per pound of steel.

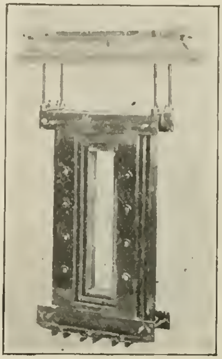


FIG. 11. TWO-LEGGED TYPE OF CORE

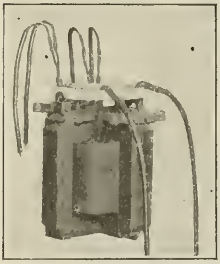


FIG. 12. STANDARD TYPE OF DISTRIBUTED CORE

Every modern transformer has what is called a closed magnetic circuit. By this is meant that the magnetic flux, as produced by the coils, is carried on its entire path through magnetic material (iron) and that there are no air gaps to cross. It is therefore necessary to provide a top and bottom yoke to the core, which is laminated just like the main leg or legs of the core. These yokes should have at least the same total iron cross-section as the main legs in order to give the flux a uni-

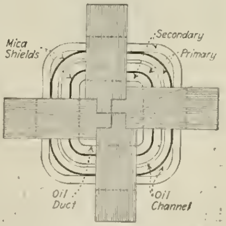


FIG. 13. END VIEW OF CORE AND WINDINGS.

form resistance along its entire path. For manufacturing reasons it is not feasible to wind the transformer coils by hand around the core legs. This means that at least the top yoke must be removable from the main legs. It is then possible to wind the coils on machines, to slide them finished over the legs, and to close the magnetic path by replacing the top yoke. It will be apparent that this makes necessary two or more joints in the complete transformer core. To make the magnetic resistance of these joints as small as possible is imperative for the most efficient operation of the transformer. Whatever method of joining is used, the metal path must be discontinued in every individual steel sheet, and it is therefore obvious that even the best method will give a magnetic joint resistance greater than that of a one-piece yoke.

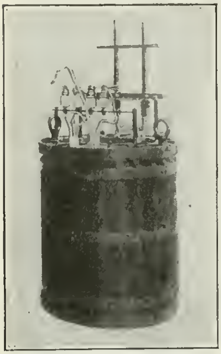


FIG. 14. CORE WITH 24 EXTERNAL LEGS

Two radically different methods are being employed today in making the joint in transformer cores—the interleaved joint and the butt joint. In the former method every other lamination of the leg and yoke is made the width of the legs shorter, so that all the longer pieces of the yoke take the place of all the shorter pieces in the core, and vice versa, as indicated in Fig. 2, which shows the thickness of the laminations greatly exaggerated. This gives a very simple and satisfactory joint. Its only disadvantage is the time it takes to open or to close sheet by sheet. The second method, the butt joint, used extensively in Europe, necessitates a very careful and most accurate finishing of the ends of the core and corresponding places of the yokes to insure a perfect magnetic contact. This finishing process, together with the heavy clamps necessary to hold the legs and yokes firmly together, makes this joint construction rather expensive.

Punchings for small transformers are made L, U or E shaped as in Figs. 3, 4 and 5 respectively. This means one leg and a part of the lower yoke, or two legs and the lower yoke, or three legs and the lower yoke are punched out of one sheet of steel in the same operation. For larger transformers the leg and yoke laminæ are punched or sheared separately.

The great majority of modern transformers use a winding of some circular nature, such as circular disk coils or cylindrical coils. It would therefore be ideal to use also an iron core of circular cross-section within these windings. However, from the foregoing it will be readily seen that as the cores must be built up of sheets it is impossible to arrive at the circular form. The simplest form of a core cross-section approaching the circle is an inscribed square, Fig. 6. Much iron is lost in the four segments. the area of the iron to the area of the circle is in proportion of 100: 158. This factor, 63 per cent., is called the iron-space factor. For very small transformers such square cores are being used occasionally. Much better results are obtained with so-called "cruciform" core, Fig. 7, giving an iron space factor of 77 per cent. It is logical to increase the number of steps in the width of core-leg laminæ, in order to better the iron-space factor. Double cruciform-shaped cores, Fig. 8, five-step cores, Fig. 9, and cores with even a greater number of steps are being used. But it is evident that manufacturing complications soon enter where too many different widths of punchings for one size of core are used.

To accommodate different types of windings every size of transformer core has to have two flexible dimensions, *W* and *H*, Fig. 10, which are called the windows.

The simplest and probably most widely used transformer core is the two-legged type, Fig. 11. It is applicable and economical for all single-phase transformers from the smallest to the largest output. On small transformers and compensators both primary and secondary windings are sometimes arranged on one of the two legs only, the other being the magnetic return. The same type but with three identical legs is used for all kinds of three-phase machines. Both types may be used with the legs standing upright or lying horizontally one above the other. Interleaved or butt joints may be used.

A type of core used in America almost universally for all small and medium-sized single-phase distributing transformers is the so-called distributed core or distributed shell design, Fig. 12. In this type the primary and secondary windings are arranged around a central, mostly polystep core, as in Fig. 13, and the mag-

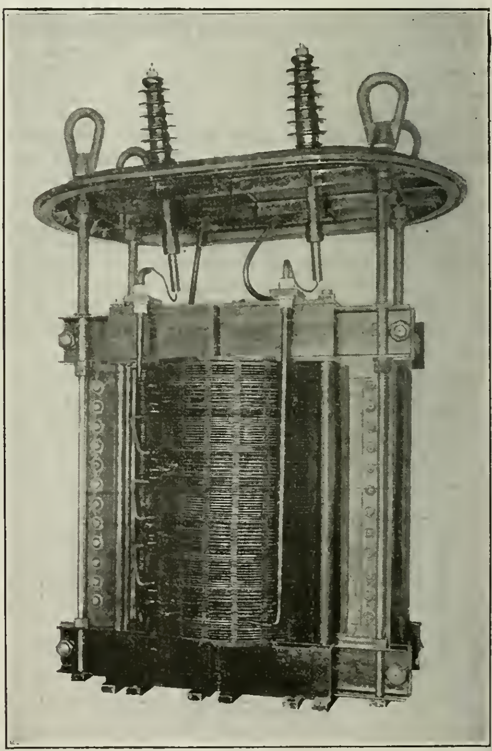


FIG. 15. SINGLE-PHASE TRANSFORMER HAVING A THREE-LEGGED CORE

netic return is made through three of four external legs. The cross-section of the external legs is equal to or somewhat greater than that of the central leg. This design lends itself readily to a very economical and rigid construction. An English concern went farther along this idea and manufactures a transformer that embodies the same principle of the distributed core, but uses as many as 24 external legs, Fig. 14. This makes the outside of such a transformer almost completely "iron-clad."

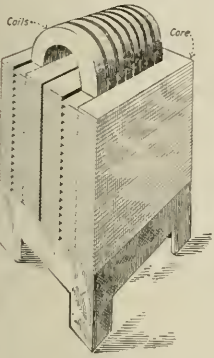


FIG. 16. SHELL-TYPE CORE

Instead of increasing the number of magnetic return paths, it is possible to design a very efficient single-phase transformer by using a core similar to the three-legged core, Fig. 10, but with the two outer legs having smaller cross-section than the center leg, and by placing both primary and secondary windings on the center leg only, as in Fig. 15. In this case the center leg only is designed with a possible maximum iron-space factor, whereas the two outer legs, carrying no windings and, serving only as magnetic returns, are usually left plain rectangular. This type of core, sometimes called "three-legged," may be used advantageously up to the largest single-phase units.

Another type of transformer core, known as the shell type, is shown in Fig. 16. The core of a shell-type transformer is similar to a three-legged core-type core, but usually contains so many laminæ as to make its cross-section long rectangularly. Consequently, shell-type transformers require long rectangular coils. In this type the core is built up around the coils, as shown in the figure. It can be said by several manufacturers the shell-type is at present being largely superseded by the core-type design. Only for transformers with an output of less than 2 kv.-a. or for air-blast designs does the iron-inclosed shell-type at present maintain its supremacy over the core type.

Safety Device for Hydraulically Operated Relief Valve

When the relief pipe of a turbine or engine installation exhausting into a surface condenser is fitted with a hydraulically operated atmospheric relief valve, there is a possibility of the operator leaving the water pressure on the piston of the hydraulic cylinder after closing the valve, when it should be shut off, thus permitting excessive pressure to build up in the condenser in case the vacuum is lost and the units attempt to operate noncondensing.

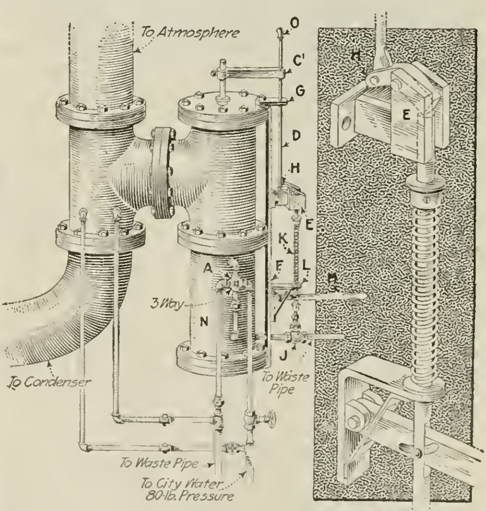
A simple but effective device has been designed in one instance to prevent such an occurrence: The 8-in. water piston that actuates the relief valve is controlled by a three-way valve *A* and is connected to the water-supply pipe and to a waste pipe, as shown. In case the operator admits city water (which is at 80 lb. pressure in this instance) in order to close the atmospheric valve, and for any reason should neglect to shut off the water pressure, a water-relief valve will automatically operate and relieve the pressure from the operating piston and thus permit the main relief valve to open before pressure is built up in the condenser.

The way this is done is as follows: The top cylinder head is drilled for the extension of the piston rod, and to this is attached an arm bent at right angles and having a hole at the outer flattened end *C*, which slides on a $\frac{3}{8}$-in. rod *D*. At the top of the rod *D* is a stop *O* and the other end of the rod is flattened and drilled with several adjusting holes so that the proper adjustment may readily be obtained for opening the water-relief valve *J*.

A bracket *E* is secured to a base that is bolted to a $\frac{3}{8}$-in. thick supporting iron *F*, which in turn is secured to the hydraulic cylinder as shown, the upper bolt also serving to hold the guide *G*. The bracket *E* is slotted at the top, in which is fitted a trigger *H*, one end of which is pinned to hold the rod *D* and the other end rests on the extension end of the valve stem of the water-relief valve *J*. The valve-stem extension is fitted with collars between which is a spring *K* that is under tension when the trigger *H* is in place. The bottom end of the extension rod is guided by an angle iron **L**, and just below the angle iron is a washer to prevent the spring *K* from having too great a movement.

One end of the lever *M* is pivoted to the bracket that is fastened to the cylinder *N*, and is attached to the valve stem by a pin that works in the slightly curved slot in the lever, which provides free movement as the valve stem moves up and down.

The operation of the device is as follows: In case the operator is suddenly called away after having opened the three-way valve, the water pressure of 80 lb. will force the piston in the water cylinder *N* up until the arm *C* engages with the knob *O*. Any further upward movement of the arm *C* disengages the latch *H* and allows the spring *K* to open the relief valve *J*, thus allowing the water pressure in the cylinder *N* to escape. This permits the relief valve to open without building up excessive pressure in the condenser.



DETAILS AND APPLICATION OF THE RELIEF VALVE

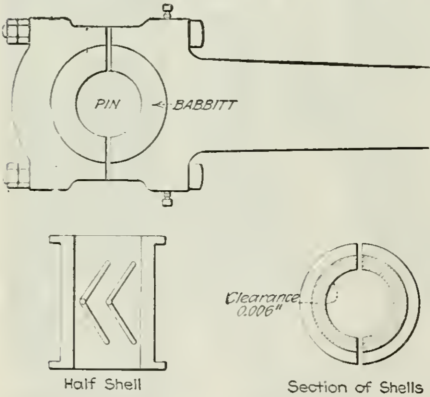
Pounding and Heating in a Diesel Engine

BY D. L. FAGNAN

AFTER having been installed only three months, a 140-hp. horizontal oil engine suddenly developed a serious case of pounding. The explosions were so violent that the safety valve opened at every power impulse. The engineer could find no cause for such an unusual occurrence, and although he kept things going, he called for help. A local machinist, known to everyone as a handy man at anything and who understood and had operated this type of engine, was called in. While examining the engine he opened the splash door to feel the temperature of the crankpin and got a lump of hot babbitt metal on the back of his hand. Before the engine could be shut down in response to his alarm, the babbitt had completely melted out of the crankpin bearing and the rough shells had damaged the pin.

The construction of the shells and rod end was about as shown in Fig. 1. The machinist made all preparations for rebabbitting and heated the shells in a charcoal stove made from red brick placed in rectangular form three or four deep. He used an 8-in. nipple for a mandrel as it allowed about $\frac{1}{16}$ in. for machining. After inserting the proper number of shims, he clamped the halves together with a couple of bars of $\frac{1}{2}$ x $2\frac{1}{2}$-in. iron and four $\frac{5}{8}$-in. bolts and turned the shells in a lathe. He then put the crankpin in good shape by filing and calipering, finally polishing the pin by using a canvas band about 4 in. wide and plenty of emery and oil. He next smeared Prussian blue on the pin and by rocking the half shells back and forth was able to scrape and fit them to a fine bearing on the pin.

He gave the usual clearance of 0.006 in., as shown in the illustration, and after cutting good oilways and smoothing their edges, assembled the bearings. Here is where he made an unfortunate mistake, as many other mechanics have done. Usually, the shells when leaving the shop are given a nice easy fit into the rod end, and as these shells seemed to be a very tight fit, he drove them home with a hardwood block and a light sledge. He gave the bearing a little play and allowed about 0.008 in. as side play, which is commendable.



Half Shell

Section of Shells

FIG. 1. CONSTRUCTION OF END OF ROD

On barring the engine over and finding that it turned easily, he started up, giving the pin considerable oil and a little graphite, but watching closely for heating. It came in a hurry. The pounding of the engine combined with the heating of the pin was serious. The bearing was saved by shutting down the engine quickly, but on examination the oilways were found piled full of babbitt. The bearing was scraped again, and after new oilways were cut it was assembled and the engine started. The same result followed, except that the bearing was so damaged that it was decided to rebabbitt. This was done and the engine was assembled, but left idle while the builders were notified to send a man to tame the critter.

The prize fell to my lot and I hurried to the plant, not knowing anything about the trouble they had been having. They declared that a sledge should have been used on it instead of good scraping tools and swore that the engine ought to be carted off to the scrap heap. When they got back to normal condition, they told me the whole story, adding that if the mechanic could not fix it in spite of his experience of 30 years on everything that would run, my chances were small.

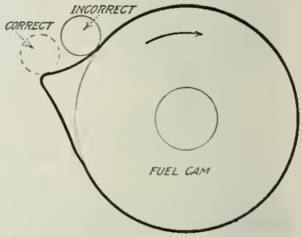


FIG. 2. ROLLER ACTUATED BY APPROACH TO CAM NOSE

Remembering what they had said about pounding, and the engine being assembled ready to run, the oil injection was checked up, revealing the fact that the engine was getting the oil 32 deg. too early. That explained the pounding as well as the fact that the safety valve spit fire at every power impulse. They had caused such an early injection of oil simply by screwing up the adjusting nut on the fuel needle until they had left no end play and the fuel needle was lifted by the approach to the fuel nose instead of the nose of the cam itself, as shown in Fig. 2. The shock must have been terrific, but unless the engine operated for some hours under such conditions, the heating of the pin would not be serious.

Some engineers would question whether an engine could be started under such conditions, but this type of engine starts easily by cutting out part of the compression, and only mild explosions take place until the release cam is put out of action and full compression occurs. The oil injection was reset at 5 deg. early by the use of a protractor. After loosening the nut on the fuel needle and having a man pump a heavy pressure until no more movement of the pump lever was possible, the nut on the fuel needle was gradually turned until a slight opening of the needle occurred, when the pump lever could easily be moved. This denoted the injection point, and by barring the engine backward slightly and then forward and bearing down on the lever of the fuel pump, the injection timing was easily checked up. The nuts were then permanently tightened and not disturbed again.

We had not yet found out why the pin heated. The pin and bearing being very large, the bearing pressure would not be high even with the pounding, and it was necessary to look further for the cause. The crankpin bearing was taken down again and I showed them the excellent bearing they obtained by rocking the half shells on the pin and using prussian blue. Leaving the blue on the bearing, it was assembled again without the shims and was tightened up fairly tight, after which the engine was turned over with air a few times. Then the bearing was dismantled and when they saw the shells they understood the reason for the heating.

The first thing they had done was to distort the shells when they melted out the old babbitt. These shells are a true circle, cut in two, a small amount being taken off each half to provide for shims, using a saw for the separating process. More distortion occurred when they poured the babbitt. They should first have fitted the shells to the rod end by filing and scraping to a nice sliding fit and then paying attention to fitting the shells to the crankpin. In that case they would not have had to force the distorted shells into the rod end by hammering, thus entirely spoiling the good job they had done by scraping and fitting. The effect of this distortion was to force the ends of the shells inward and cause them to grip the pin at the point where they met. We proceeded to fit the half shells to the rod end and then to the crankpin, and when the engine was started again the heating troubles were at an end, as only a slight temperature was observed.

Test Shows Over 82 Per Cent. Efficiency of Motor-Driven Centrifugal Pump

In a paper read before the Minnesota Section of the American Water Works Association, F. W. Capellen, city engineer of Minneapolis, stated that in May, 1911, the city entered into a ten-year contract with the Minneapolis General Electric Co., now the Northern States Power Co., by which that company agreed to furnish current at 2200 volts to operate two or more 20,000,000-gal. pumps against a dynamo head of 240 ft., based upon a pumping set of 72 per cent. over-all efficiency, at a price of $4 per million gallons pumped, the understanding being that no current would be used between 4:15 p.m. and 6:30 p.m. on week days during the months of November, December, January and February. In November, 1916, a similar ten-year contract was made with the same company for the operation of a 30,000,000-gal. pump against the same head, and with the same efficiency, to be charged for at the same rate, with the provision that at a different dynamic head or efficiency the price should be adjusted accordingly. It was also specified that the motor to be used by the city should be capable of starting the pump when primed and with the check or gate valve in the discharge closed, and of bringing the pump to full speed without drawing more than 150 per cent. of full-load current from the source of supply. In 1910 and 1911 two 20,000,000-gal. pumps were installed, and in 1918, a 30,000,000-gal. unit.

The latter consists of an 1800-hp. three-phase G.E. slip-ring induction motor directly connected to two De Laval 24-in. single-stage pumps mounted on the same baseplate and connected in series. The unit was specified to deliver 30,000,000-gal. per 24 hours against a total dynamic head of 250 ft. It was supplied by the Minneapolis Electric Equipment Co. and is installed at Pumping Station No. 4 in North East Minneapolis.

The official acceptance test was made on May 28 and 29, 1918. The discharge was measured by means of a venturi meter, the capacity being calculated from manometer readings, while the discharge head was measured by two sets of calibrated gages and the suction lift by means of a mercury column. The power supplied was measured by three sets of watt-hour meters, calibrated by means of a portable set of standard instruments read during the official test under the conditions of current, voltage and power factor obtaining. The portable set included two single-phase wattmeters, one polyphase wattmeter, one voltmeter, four ammeters, and portable current and potential transformers. All intruments were checked and calibrated in the presence of witnesses. The test lasted 28 hours. The results were as follows:

Total pumpage in 28 hours, gal.	37,719,500
Rate per 24 hours, gal	32,331,000
Discharge head, average, ft	235.13
Suction lift, average, ft	16.43
Total dynamic head, average, ft	251.56
Kilowatt-hours used	36,307.2
Combined efficiency of motor and pump, per cent	82.1
Average line voltage	2,406
Power factor, per cent	90.0
Motor efficiency under test conditions, per cent	95.5
Slip of induction motor, per cent	1.1
Temperature rise, deg. C	33.5
Starting current, percentage of full load current	113.0

The contract of the city with the Minneapolis Electric Equipment Co. provided a bonus of $500 for each 1 per cent. of efficiency exceeding 76 per cent. when pumping 30,000,000 gal. per day against a total dynamic head of 250 ft. The maximum bonus was limited to $2400. A penalty of $500 was provided for each 1 per cent. by which the efficiency might fall below 76 per cent., and the pump was not to be accepted if the over-all efficiency fell below 72 per cent. Seventy-six per cent. efficiency was exceeded at all loads tested, and the average combined efficiency, including the regular starting and other conditions incidental to a varying load in regular service, should not be less than 82.1 per cent. by more than 1 per cent. The over-all efficiency of 82.1 per cent. divided by the motor efficiency of 95.5 per cent. gives 85.97 per cent. pump efficiency.

The following operating data were obtained during the first three months after the test:

Gallons pumped	2,797,490,000
Power cost, per million gal.	$3.63
Labor and supplies, per million gal	$2.27
Total cost, per million gal.	$5.95
Head, ft	253.06
Over-all efficiency, per cent.	81.4

Similar records for the first nine months subsequent to the test are as follows:

Gallons pumped	6,526,350,000
Power cost, per million gal	$3.72
Labor and supplies, per million gal	$1.77
Total cost, per million gal.	$5.49
Head, ft	255.80
Efficiency, per cent	82.48

Figures are also available from two triple-expansion Holly-A frame pumps installed in the same plant in 1903 and 1904, and tested in September, 1904. These pumps have a capacity of 15,000,000 gal. per day each, and on test developed a duty of 162,000,000 ft.lb. per 1000 lb. of steam, reduction being made for slip. During 1908 the two steam pumps raised practically all of the water for the city; namely, 6,518,000,000 gal. against 250 ft. head. The cost of fuel, using Illinois screenings at $2.07 per ton, was $3.01 per million gal., the cost of labor $3.33, and other pumping costs 35c. per million gallons, making a total of $6.75. The cost today, with coal at $4.93 per ton, would be approximately $12.74 per million gallons. The low prices which the city realizes on its power contracts with the electric company are of course explainable in that the contracts were made some time ago and for a long term.

The Electrical Study Course—Addition of Alternating Voltages

Compares the addition of alternating voltage with the addition of direct voltages, and shows how to obtain the value of two or more alternating voltages in series.

When determining the value of the voltage across a number of direct-current sources in series, it is merely necessary to add the values of the various sources in order to get the total voltage. Thus, in Fig. 1, three generators, *A*, *B* and *C*, are connected in series in such a way that all the voltages are added, making the voltage across *ab* equal to 110 + 125 + 240 = 475 volts. Hence, it is seen that in the case of direct voltages it is merely necessary to know the values in order to figure their sum.

When adding alternating voltages, however, it is necessary to take into consideration not only their values, but also what is called their phase relations. To make this clear, let us suppose that we have two alternating-current generators *A* and *B*, connected in series as shown in Fig. 2, and that their armatures are coupled together. Furthermore, assume that when the taps *ab* of *A* are at the center of the polepieces as shown, those of *B* are midway between the polepieces as shown in the figure. At the instant represented the voltage of *A* would be zero and that of *B* maximum. After a quarter turn of the armatures, as in Fig. 3, the voltage of *A* would be maximum and that of *B* zero. Assume that the maximum voltages of *A* and *B* are 100 volts and 200 volts respectively. The curves that correspond to the voltages generated during the revolution are shown in Fig. 5. It will be noticed that the maximum value of one is always 90 deg. away from the maximum value of the other, a fact indicated by the right angle separating the vectors, E and E_B, at the left in the figure.

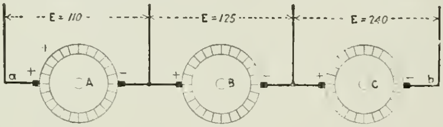


FIG. 1

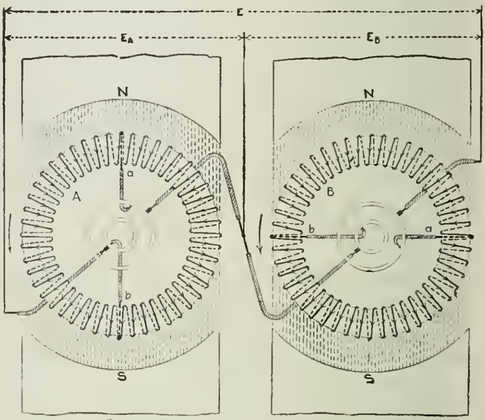


FIG. 2

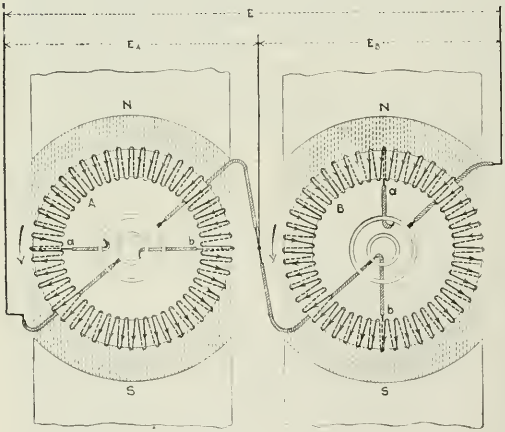


FIG. 3

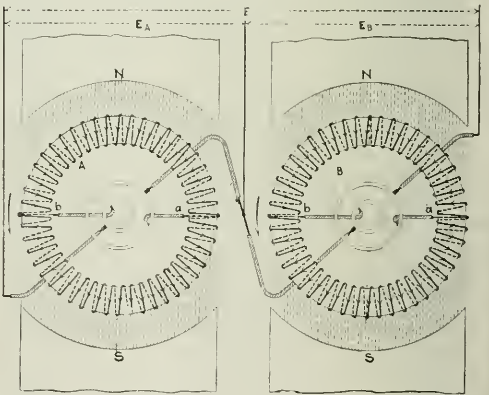


FIG. 4

FIGS. 1 TO 4. DIRECT-CURRENT AND ALTERNATING-CURRENT GENERATORS CONNECTED IN SERIES

This angular difference is called the phase difference of the voltages. For example, we would say that there is a phase difference of 90 deg. between the voltage of *A* and that of *B*. This phase difference between two generators depends entirely upon the relative positions of the taps *a* and *b* in reference to the polepieces. Thus, if the coupling between *A* and *B* of Fig. 2 were to be opened and armature *A* be given a quarter turn and the coupling reconnected, both sets of taps would occupy the same relative position as in Fig. 4 and the voltages would have no phase difference; they would then be said to be "in phase." Shifting the armature of either generator through some other angle would give us some other phase difference.

Returning now to the problem under investigation—

namely, the addition of alternating voltages—let us see what the result would be in the case of the two voltages, E_A and E_B, that we have under consideration. Referring to the curves of Fig. 5, it is evident that at 0 deg. $E_A = 100$ volts and $E_B = 0$ volts, and that their sum is therefore $100 + 0 = 100$ volts. If we let E_0 represent the combined voltage at zero deg., we have $E_0 = 100$ volts. At 90 deg. we would have $E_A = 0$ and $E_B = 200$ volts, so that $E_{90} = 0 + 200 = 200$ volts. Likewise, E_{180} will be found to be 100 volts below the *xy* line, and so on. In fact, to obtain the voltage at any part of the cycle, all we have to do is to add the distances of the curves from the *xy* line.

In Fig. 6 the curves of Fig. 5 have been repeated, and additions of their heights are shown for every 30 deg. Thus the point b_3 is obtained by adding the height bb_1 to the height bb_2, c_3 by adding cc_1 to cc_2, etc. At the 120-deg. position ee_1 is below the *xy* line and ce_2 above it. It is therefore necessary to deduct the length ee_1 from ee_2, leaving the height ee_3. The same procedure must be followed in all other cases in which the distances are on opposite sides of the *xy* line.

It will be noticed that the curve *E* that is drawn through the resultant points is a sine curve like the two of which it is the addition. However, the maximum value of curve *E* is only slightly greater than the maximum of E_B and nowhere near the value we would have obtained if we had added the maximum values of E_A and E_B. which would have given us $100 + 200 = 300$ volts. Since *E* is a sine curve, its maximum height could be represented by a vector, which would in that case represent the vectorial sum of E_A and E_B, as shown to the left, Fig. 6. Since the maximum values of this resultant occur at angles different from those at which either E_A or E_B has its maximum value, it follows that the resultant is out of phase with both of the added or component voltages.

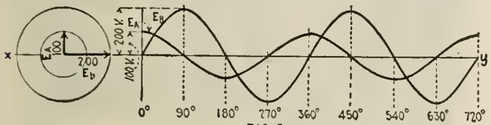


FIG. 5

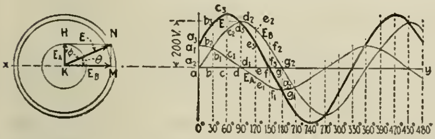


FIG. 6

FIGS. 5 AND 6. ADDITION OF TWO ALTERNATING VOLTAGES 90 DEGREES OUT OF PHASE

It has been found that there is a very easy method of determining both the value and the angle of the resultant voltage. This consists of constructing a parallelogram, such as *HKNM*, shown on the left in Fig. 6, the lengths of whose sides are equal to E_A and E_B, and then drawing the diagonal from *K* to *N*. The length of this diagonal is equal to the maximum of the resultant voltage, and θ and ϕ are the angles by which it differs in phase from E_B and E_A respectively. It is thus seen that it is unnecessary to undertake a cumbersome construction such as that of Fig. 6 in order to determine the sum of two alternating voltages, since the resultant curve *E* can just as well be constructed from the vector *E* of Fig. 6 after this vector has been constructed in the manner just described. It will be noticed that in Fig. 6, *KMN* is a right triangle of which the side *KM* is equal to E_B and the side *MN* to E_A. Consequently, we have that $(E)^2 = (E_A)^2 + (E_B)^2 = (100)^2 + (200)^2 = 50{,}000$, from which $E = \sqrt{50{,}000} = 223.6$ volts, showing that the sum of the voltages can be obtained mathematically without resorting to any construction at all, when E_A and E_B are at right angles to each other.

When the two voltages are in phase, their sum is found by simple addition. This case is illustrated in the curves, Fig. 7. The resultant vector *E* is equal to $E_A + E_B$ and is therefore 300 volts. Adding the two curves E_A and E_B will give the resultant curve *E*.

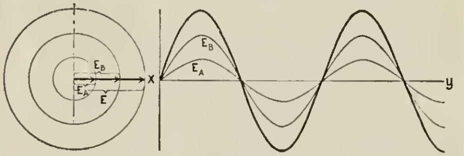


FIG. 7. ADDITION OF TWO ALTERNATING VOLTAGES IN PHASE

Problem 1 in last lesson was to find the voltage at instants 25 and 65 deg. in an alternating-voltage cycle, Fig. 8, the maximum value of which is 250 volts. In the previous lesson it was shown that the voltage at any instant in a sine curve of alternating electromotive force is equal to the maximum value times the sine of the angle at which the voltage is calculated. In this problem it is desired to determine the voltage at 25 and 65 degrees. Sin 25 deg. and sin 65 deg. are 0.4226 and 0.9063 respectively, as found from a table. Therefore, if we let the maximum volts be represented by *E* and the instantaneous volts by *e*, we have at 25 deg. of the cycle, $e = E \sin 25 \text{ deg.} = 250 \times 0.4226 = 105.6$ volts, and at 65 deg. $e = E \sin 65 \text{ deg.} = 250 \times 0.9063 = 226.6$ volts.

In problem 2 it was requested to find the cycles per second and the alternations per minute of a 16-pole alternator running 187.5 revolutions per minute. In the last lesson it was shown that the frequency, $f = \frac{PS}{120} = \frac{16 \times 18.7}{120} = 25$ cycles per second. There are two alternations per cycle and 60 seconds per minute, therefore in this problem, alternations per min. $= 25 \times 2 \times 60 = 3000$.

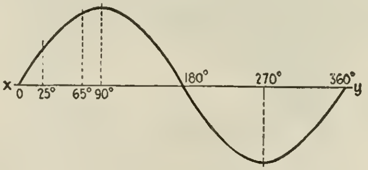


FIG. 8. SINE CURVE

1. Two alternating voltages, one of 300 volts and the other of 400 volts, have a phase angle of 90 deg. What would be the resultant voltage if they were to be connected in series?

2. At what speed must a 12-pole alternator run to generate a 50-cycle voltage?

Jim and Fergus Go Visiting

By JAMES F. HOBART

"HEY, JIM! Let's visit the Big Four shops at Beech Grove, about ten miles from Indianapolis. There's a lot of stuff down there that is worth seeing." And so we went to Beech Grove, and we were mighty glad we did. Two of the turbines were running, furnishing current to operate the big shop; but the third one had just been dismantled and part of it sent to their own shop for repairs.

I didn't want Fergus to get "in bad" with the chief, so I wished him upon the assistant engineer, who took him into the boiler house and let him go snowblind from looking into the combustion chambers of some of those big boilers where the fire was white hot.

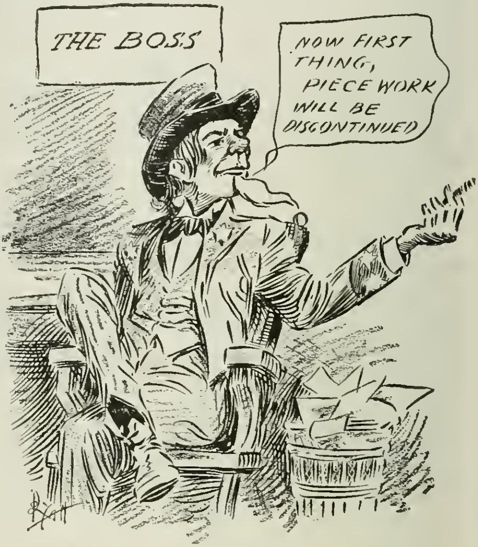
While we were returning to town, Fergus asked me what the assistant meant by his remark regarding stokers when he said, "stokers are just like women—the most interesting things in the world, but a fellow never understands them." "Now just what did he mean?"

I put two and two together, pieced Fergus' remarks with what the chief had said and concluded that they were having the time of their lives with their stokers and with various kinds of coal. The chief had stated that he always asked for West Virginia coal, but during the war period he was mighty glad to get any coal at all, of any kind.

FIG. 1. "WE DO OUR OWN REPAIRS," SAID THE CHIEF

The chief had also said that when he had to burn West Virginia coal one type of stoker was right in its glory and he never wanted anything better, but that the coal did not burn so well with the other type of grate. When he had to burn Indiana or Illinois coal, then things were different, and the stoker action was just reversed, the one giving satisfaction with West Virginia coal freezing up.

While inspecting the plant I asked the chief what power factor he ran under and he replied about 72 right then, but that it was not very good, although it used to be a whole lot worse before the Government took over the railroad and the shops. Said he: "Then, when piecework was the rule, the men would start some of the big machines that are scattered throughout the shop, use a machine for a few minutes perhaps, and then allow it to run idle all day. Such work as that just raises 'hob' with the power factor. It overloads the generators and underloads the turbines, and there you have it. Since the Government has taken over the shops and abolished piecework, things are better. They are after some efficiency from the big machines and will not let them run except when in use, and that and other changes have raised the power factor from 40 or 50 to 72. That is not bad, considering that the steam plant is operated noncondensing and that the peak load on the two generators sometimes runs up to 1250 or 1300 kilowatts."



THE BOSS
NOW FIRST THING, PIECE WORK WILL BE DISCONTINUED

FIG. 2. GOT DOWN TO BUSINESS AT ONCE

"But why is the plant run noncondensing?" I asked.

"Because," replied the chief engineer. "the water supply has fizzled out. When the plant was first put in, there was plenty of water and we used to pull a vacuum of over 29 in., not by a spring gage, but on a correct mercury column. We used so much water that we didn't raise its temperature more than three degrees in passing it through the condenser. But things have changed. We used to pump it but twenty feet; now, we have to pump it two hundred feet. So we just cut out the whole business and are running noncondensing. You know what that means with turbines. It cuts off the real economy and leaves only the cost and the expense.

"Yes, sir! That is all there is to the turbine business. The high-pressure end is cost and trouble, and the low-pressure portion is economy and comfort. All the profit of running a turbine comes from the low-pressure end, and that being cut off, as in our case, leaves us in a pretty bad fix. I have been trying to induce the powers that be to put in a spray pond so we could cool the water and use it over and over again, but I don't know when I will get it.

"To prove that it would be profitable to them, I gave them facts and figures which they accepted right off the reel and said it was a good thing and that I ought to have it. But that makes it all the worse, for I find that the things to which they agree the quickest are the slowest in coming. I had rather that they had opposed the scheme a bit and that I had argued the matter with them, for then they are much more likely to come across when convinced. But now the thing is likely to drag along without my ever hearing from it again.

"Yes," continued the chief, "I have proposed an idea for getting all the direct current they want for nothing, save the first cost of the machinery, plus nothing for operation. We use a good deal of direct current in the shop, and those two motor-generators are running all the time. I have shown them that by putting in a mixed-pressure turbine and using the exhaust from the steam hammers in the shop and the exhaust from some other steam-using shop tools, they could run a 220-volt d.-c. generator with the occasional use of a very small quantity of live steam, thus doing the work with the exhaust steam and the regulation with the high-pressure steam.

①
IT MAY BE AN IMPROVEMENT BUT IT COSTS MONEY. GOOD DAY
②
A CONVENIENCE! PERHAPS. BUT THERE'S THE ELEMENT OF COST. NOTHING DOING
③
YOU CERTAINLY PUT IT WELL. HOWEVER, THE FINANCIAL CONSIDERATION REMAINS.
④
WHAT'S THAT? THE FINANCIAL CONSIDERATION SHOULD INDUCE US TO INSTALL IT? JUST WHAT DO YOU MEAN?
⑤
EH! YOU SAY IT WILL SAVE US MONEY. NOW THAT SOUNDS SENSIBLE!
⑥
YES, YES, GO ON. YOU INTEREST ME STRANGELY!

FIG. 3. WHEN THE CHIEF ARGUED FOR IMPROVEMENTS

"This would cost nothing but the installation of the machinery. It would do away with the use of the two motor transformers, which are a large part of our load, and I could do all the rest of the work with one turbine instead of the two now in use all the time. But," he added, "maybe I'll get that and the spray pond as well as soon as we get the cross-compound engine that has been authorized for several years, and which has not arrived."

"How does it happen that the exciter unit is set right in the center of the station, between the motor generators and the three turbine generators, which are on the other side of the exciter?" I asked.

"It was placed there by the designer of the plant" replied the chief, "and I am very glad that it was, because we use that exciter a lot when the rest of the plant is not running, nights and Sundays, and for charging storage batteries on cars after having been repaired or overhauled in the shop. We build up just the voltage required and let the exciter run direct to the batteries at that voltage.

"Some amusing things have happened in connection with battery charging. One morning one of the runners was fussing around the exciter when I came in. He said he could get no voltage indication on the exciter voltmeter no matter what he did.

"I told him that he had got its polarity reversed, but he could not be made to see how that could have happened. The machine was exciting the alternators all right, but nobody knew what voltage it was giving as the machine could not indicate upon the voltmeter when reversed. At the first opportunity we reversed the polarity of the fields and the voltmeter at once went back to business.

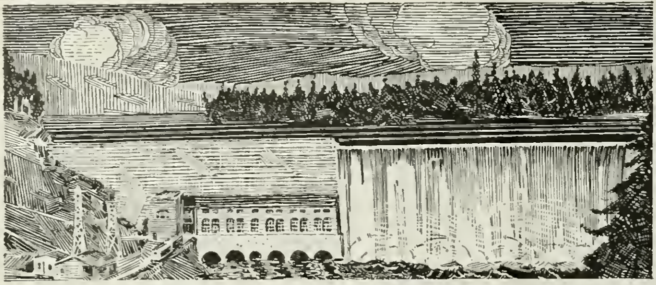
"I was curious to know how the fields became reversed and so pressed the man for an exact account of just what he had done when starting the exciter. It developed that he switched on the batteries that were to be charged and then stepped around and started the exciter. 'Threw on the batteries before you started the exciter, did you?' I asked. 'Didn't you know that would reverse the fields?'

" 'How could it do that?' he asked. 'It was not one second after the batteries were on before I started the exciter. How could the fields reverse in that short time?'

"Well, to this day I have not been able to make that man see that the exciter fields did not require time instead of instantaneous action to be reversed.

"Another time," said the chief, "the exciter was reversed, probably in the same manner. It was on Sunday and nothing was running in the power house, and it became something of a question as to how I was to reverse the exciter fields again. Finally, I went to the storage-battery house and found they had one battery there that was about half charged. It was connected to the charging line from the power house, and after putting paper under the exciter brushes it was started up and I finally got it reversed by the current from the storage battery."

The question as to where disabled ex-service men are being reëducated is answered by the fact that 5077 disabled soldiers, sailors, and marines under the direction of the Federal Board for Vocational Education are in training in more than seven hundred different institutions throughout the country. No less than 546 schools and colleges now number wounded soldiers among their students; and 198 commercial and industrial establishments have disabled men on their forces learning trades. In order to give the men the kind of courses they want as near their homes as possible, the Federal Board for Vocational Education has selected all types of institutions for their training.



POP'S WATER-POWER COURSE

By
John S. Carpenter

"HEY, Jimmy, look me over, kid. Say, don't I look happy?" joyously exclaimed Pop as he strutted into the turbine room with a fat, black cigar at a rakish angle.

"Spill it, Pop, and tell me the glad tidings," responded Jimmy, mopping his brow.

"Well, jes' as I got through feedin' at the Greasy Spoon Beanery they was an extry come out announcin' the slidin' down the chute of old Kaiser Bill. The latest dope has it that he's goin' so fast that the royal pants has wore through and the splinters is goin' deep into his brains." Pop smiled from ear to ear and paced the floor with unalloyed satisfaction.

"I'm glad it's over, Pop. I was wishing—"

"Hey, Kelly," interrupted Pop, "tie down the big whistle and let her alone till I hollers." Turning again to Jimmy: "And what's more, the load bein' light, I'll git Casey to stay here so you and me kin go up the creek and see our new plant."

"Thanks, Pop; I was wishing for something like that. Then we can talk over all the fine points." So saying, Jimmy washed up and slipped into the uniform of civilization, and the two hopped into Pop's Ford. It was plain that Pop felt devilish, for he let the contraption out wide open and it was not long before they could see the dam of the new water-power plant. Pop tied the Lizzie at the log-boom anchorage and they got out.

"I can guess, Pop, that this is the log boom," said Jimmy, lighting one of Pop's fat, black cigars. "These logs are joined together by short pieces of chain spiked to the logs. I don't need to be told that they are intended to catch the driftwood and weeds coming down the river and so protect the turbines."

"Darn right, son. Now, when the place gets cluttered with drift, they send somebody out in a rowboat to clear it. The space behind the log boom and in front of them things up there that looks like prison doors—what they calls racks—is called the forebay."

"I s'pose that the racks are to catch any small trash that the log boom lets pass," volunteered Jimmy.

"Yep, but more partic'ler to catch leaves. Let's go down on top of that runway acrost the racks."

Jimmy seemed to be bothered about something which he presently voiced.

"How in thunder do they clean out the leaves, Pop?" As they got to the runway, they stopped to look at a ditch-like affair in the runway floor.

"See them rakes?" asked Pop, pointing to some stout-looking rakes with twelve-foot handles. "Well, they rakes the leaves up them racks and then dumps 'em into this ditch; then, you can see that the thing slopes considerable, so with these hose connections they gits water to flush the leaves out over into the spillway side."

Now they had a good look at the racks. They were made up in sections about 3 ft. wide and 10 ft. long. The bars of the racks were of 3-in. flat iron ¼ in. thick and spaced about ¾ in. clear between the bars. The sections were tied together with ¾-in. bolts through short pipe spacers.

Satisfied as regards the racks, the two went back a little, and Jimmy, always curious, blurted out: "Say, Pop, see the grooves in the side walls of the penstocks? What are they for?"

"Them, the lecturer told us, are the stop-log grooves. S'pose they want to drain the water out of this forebay, they throw them dressed timbers across the forebay with the ends in them grooves, so by and by they have a timber wall that will be tight enough to let a man go down and work in the forebay."

"Very fine," agreed Jimmy. Then, clearing his throat for a grandstand play, he began, "Now, Pop, how do they know what size to make the forebay and how wide to make the racks?"

"That's just what you didn't git at the last lecture," declared Pop as he relighted his cigar stump. "All that fine dope, all that high-brow chatter passed in one ear and out the other."

"Of course," pleaded Jimmy, trying to justify himself, "I can see that the passages must handle so much water at a certain velocity."

"Well, it's this way," Pop responded. "The velocity through the racks and penstocks is usually about 1½ ft. per second on low-head plants. If, for instance, you have to handle 150 cu.ft. per second, dividin' by 1½, we git 100 sq.ft. area. Now, that could be made 10 ft. wide and 10 ft. deep, or any other reasonable dimensions that would equal 100 square feet."

"If the velocity allowed through the racks is the same as that through the penstocks, why is it that the forebay was widened out just in front of the racks?" protested Jimmy as he pointed toward the racks.

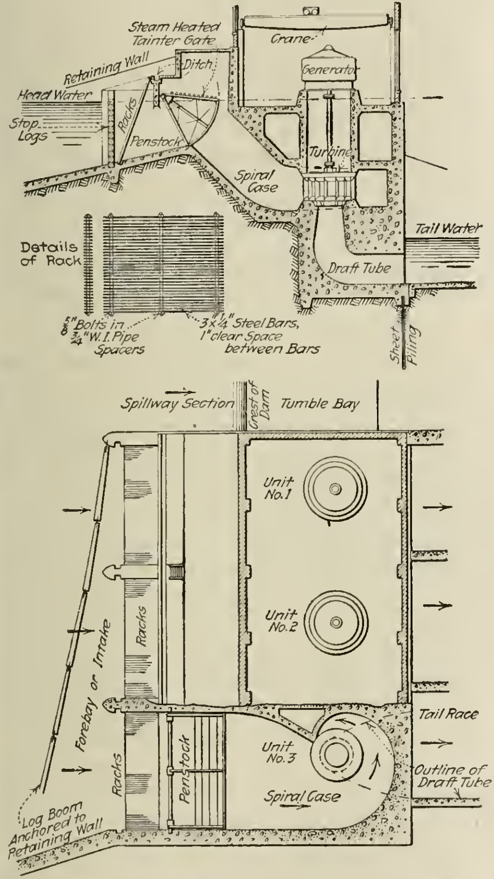
"Son, do you need to be told that them rack bars—there's about a million of 'em I guess—take up some of the area in the passage?"

"I pass, Pop. I'll buy the cigars; you're right."

"How they get to know what velocity to allow is what got me all het up at the last lecture. You heard me ast him?" Jimmy nodded. "Well, what I got out of it is this. If they make the passages very large, the friction will be low and revenue will be saved because power will be saved; but agin this we must charge the extry first cost and the interest on the investment. On the other hand, if the velocity is high, so's the friction, and some power is lost that might 'a been fed to the busbars; but the first cost of the penstocks and the interest is less. So the wise engineer will try to take account of all this and proportion his penstocks accordin'."

"I didn't get all that he said about spouting velocity," said Jimmy.

"The spoutin' velocity of water is jes' that velocity the water would have when flowin' out of a nozzle because of its pressure. If the water was under 16 ft. head, the spoutin' velocity would be about 32 ft. per second. If it's under 64 ft. head, it's 64 ft. per second. You jes' multiply the square root of the head by 8—or 8.02 if you want to be real fussy."



SECTIONS OF HIGH-EFFICIENCY PLANT FOR HEADS OF FROM 15 TO 50 FEET

"Oh, now I see; it's just the same velocity that a falling body would have after falling so many feet."

"Yep, Jimmy, that's it. The velocity goes up with the head, until at very high heads it gits so it'll eat castin's if there's any grit in the water. Makes a fine sand blast."

Jimmy made a rapid but accurate mental calculation. "Say, Pop, on that high-head Swiss plant where they got 3000 ft. head I just figured that the spouting velocity was 440 ft. per second or just 5 miles per minute. Some speed to that water!"

"Now, son, remember how to figger the spoutin' velocity, because the lecturer told us that we'd have to use it when studyin' turbines; for all turbines are designed on so many per cent. spoutin' velocity here and so many there. I figgered out a table of spoutin' velocities for my own fun and here it is:

Head....	1	10	20	30	40	50	60	70	80	90	100	200
Velocity..	8	25	36	44	50	57	62	67	72	76	80	114

You notice that the spoutin' velocity goes up pretty fast compared to the head at first, but after a while it slows down."

Through a stair well they went down to where they could see the Tainter gates, which seemed to Pop to give occasion for one of his eloquent explanations.

"They calls these things Tainter gates, and they is nothin' more than a thing to shut off the water with. Now, this one right here," explained Pop, bending low, "is het with steam, the idea bein' that when this one melts up the ice that is sure to form around it, they can start the water flowin' with it and then, as soon as the water is circulatin', it will tend to break up and melt such ice around the other gates. Now, in under that big cover are the heatin' coils that are connected to the donkey biler inside the generator house.

"Say, Jimmy," exclaimed Pop, looking earnestly at his Ingersoll, "it's time to go. The next time we'll crawl into the spiral case, down the draft tube and take a peep at the spillway."

While Jimmy extracted himself, Pop had the Lizzie cranked and they were off.

British Government Support of Foreign Trade

The development of British overseas trade is a question which is much before Parliament these days, says the American Chamber of Commerce in London, and the news in this line is of significant interest to American exporters.

The industrial group in the House of Commons is understood to have entered into the question and to be urging upon the Government the necessity for reorganizing the British diplomatic and consular services as a matter of national protection. This industrial group is urging particularly a department of overseas trade, which shall be much more highly organized and extensive in scope than the present department and that having been founded to assist business and business men, its head should be a man well trained and versed in business affairs and free from political or departmental handicaps or prejudices. The basic points of the policy which the industrial group recommends are:

1. The unification and specialization of the diplomatic and consular services for dealing with the defined trade and racial areas.

2. The best method of bringing into touch British business men who are specially acquainted with the trade and affairs of foreign countries with the officials of the Department of Overseas Trade dealing with those countries.

3. The best method of maintaining an interchange of opinion and information between all British chambers of commerce in foreign countries and official British representatives in those countries.

Alignment Chart for Finding the Properties of Saturated and Superheated Steam

By CLINTON E. PEARCE

The accompanying chart for finding the thermal and physical properties of steam simplifies the solution of various problems relating to the generation and use of steam. Its accuracy is comparable to that of the ordinary slide rule, and so it gives results sufficiently close for most engineering requirements.

After water has been heated to the boiling point corresponding to the pressure exerted on it, further addition of heat does not increase the temperature. Instead, the water begins to vaporize and form steam, and the volume increases rapidly. If the water and the steam are considered together, this gradual formation of steam will give a mixture in which the amount of water is continually decreasing while the amount of steam is increasing. The mixture is called wet steam, because of the moisture in it. The percentage of steam in 1 lb. of it is called the quality, and is designated by the letter x; and the percentage of water, especially when small in amount, is called priming. Thus, water has a quality of 0; a mixture of 2 lb. of water and 3 lb. of steam has a quality of three-fifths, or 0.6; while steam primed 2½ per cent. has a quality of 97½ per cent., or 0.975.

The Heat of Vaporization

The amount of heat required to vaporize 1 lb. of water of a given temperature into dry steam at the same temperature is known as the heat of vaporization and is designated by the letter L. When the steam is wet and part of the full pound is still in the form of water, the heat that has been added is less than L and is directly proportional to the amount that has been vaporized, or, in other words, to the quality x. The general expression for the heat of vaporization will then be xL, in which x may vary from 0 to 1, and L will change somewhat with the pressure.

The amount of heat added to 1 lb. of dry steam to superheat it may be calculated from the product of the amount necessary to raise 1 lb. through 1 deg., and the number of degrees it has been raised, or superheated. Therefore, if a is the number of heat units required to raise the temperature 1 deg. and S is the number of degrees of superheat, the general expression for the heat added will be aS. The value a for any substance is known as the specific heat of that substance. For water a is equal to 1, but for superheated steam it varies with both the pressure and the temperature and must be read from complicated tables.

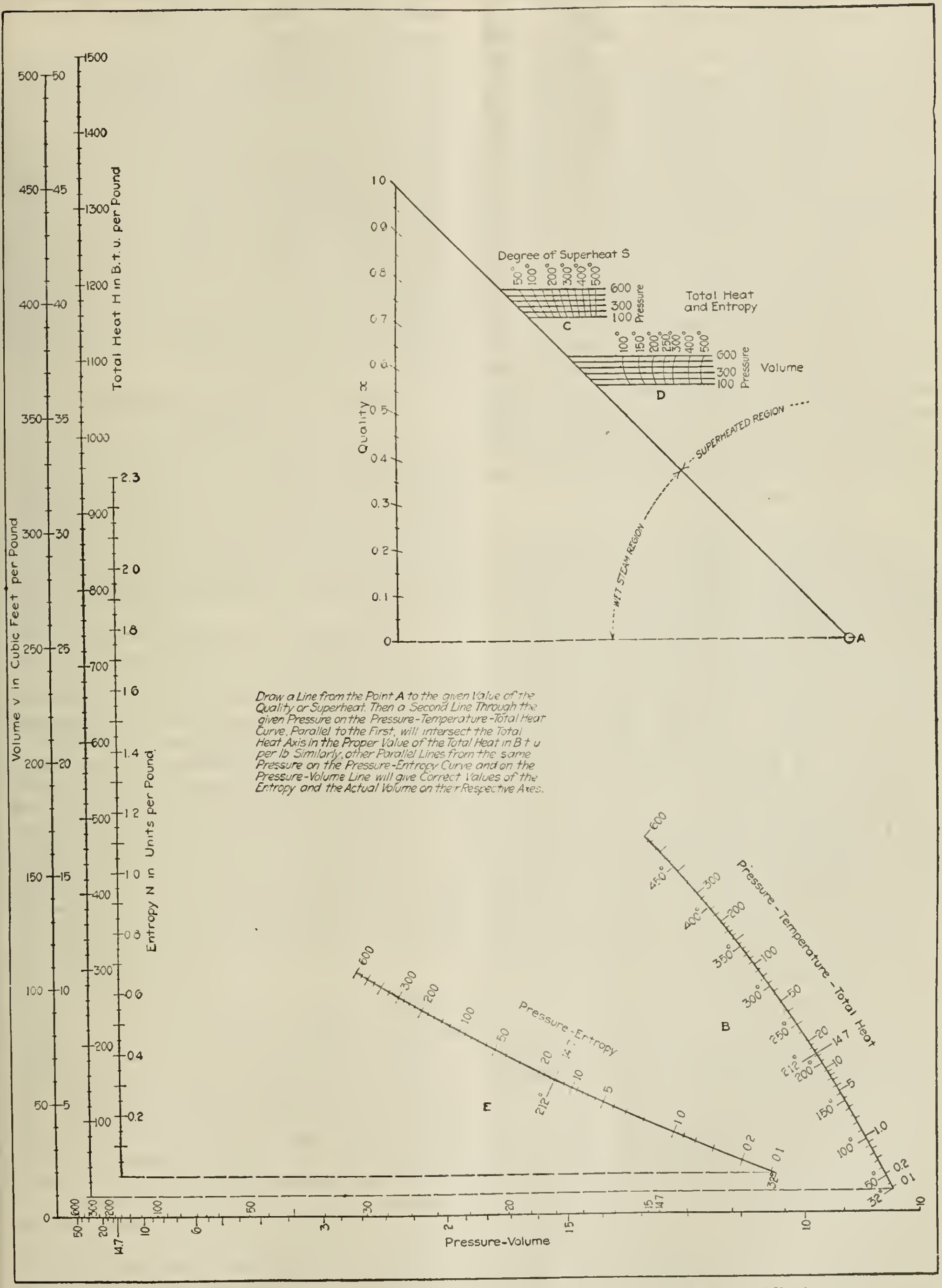
The total amount of heat necessary to raise 1 lb. of water from 32 deg. F. to the boiling point, and then to evaporate it either to a quality x or to a superheat S, is called the total heat and is designated by the letter H. The general expression for this value for wet steam is $h + xL$, and for superheated steam it is $h + L + aS$. Therefore, if water alone is considered, the quality is zero, and $H = h$; and if the steam is dry but not superheated, the quality is unity and $H = h + L$; h represents the heat of the liquid.

The volume of 1 lb. of water at 32 deg. F. and under 14.7 lb. pressure is 0.016 cu.ft., and the volume at 468 deg. F. and 600 lb. pressure is 0.02 cu.ft. This is so small in comparison with the volume of the dry or superheated steam made from the same water that it can be neglected in practically all problems; therefore, it will be assumed that the volume of water is zero in wet steam. Thus, in wet steam of a quality x the volume will be that of the steam alone and will be proportional to x. The volume of 1 lb. of dry steam is known as the specific volume and is designated by the letter v. The expression for the actual volume of wet steam will be xv. When superheated steam is considered, the actual volume must be found from complicated tables, as there is no simple relation between it, the amount of superheat, and the specific volume.

Total Entropy Made Up of Three Parts

Just as total heat is made up of three parts—heat of the liquid, heat of vaporization and heat of superheat—so total entropy, designated by the letter N, is also made up of three corresponding parts, called the entropy of the liquid, the entropy of vaporization and the entropy of superheat. The expressions for the first two values are n and $\frac{L}{T}$. Heat is added to water or to superheated steam while the temperature is changing, and the calculations required to find the value of the ratios during these operations are very complicated; so n must be taken from tables. During evaporation the temperature is constant, and consequently the value of the entropy is L divided by T, the letter T representing absolute temperature. The total entropy of wet steam can be calculated from the expression, $n + x\frac{L}{T}$, but its value for superheated steam must be found from charts or tables. There is no name for the numerical value of these expressions, so they are merely stated as so many units of entropy.

To avoid the use of cumbersome tables, which may require many pages to list all the necessary information, some authors have published complicated charts to show all the various properties of steam, including the effect of having it wet or superheated. Two of the five fundamental properties are usually selected as the horizontal and vertical scales or coördinates, and then a multitude of cross-curves have to be drawn in to represent the other three, together with different values of x and S. The general advantage of using such charts is that all required values can be read at once without any calculation. The accuracy depends upon the size of the chart, but is always less than that of the tables. The very complexity, however, of these charts makes finding the proper point of intersection



Draw a Line from the Point A to the given Value of the Quality or Superheat. Then a Second Line Through the given Pressure on the Pressure-Temperature-Total Heat Curve, Parallel to the First, will intersect the Total Heat Axis in the Proper Value of the Total Heat in B t u per lb Similarly, other Parallel Lines from the same Pressure on the Pressure-Entropy Curve and on the Pressure-Volume Line will give Correct Values of the Entropy and the Actual Volume on their Respective Axes.

CHART FOR FINDING THE PROPERTIES OF SATURATED AND SUPERHEATED STEAM of two of the many lines an operation that is greatly liable to error unless extreme care is used.

The accompanying chart shows a method of graphically representing the variations in the five fundamental properties of steam, with different values of x or of S, that is much more convenient than the usual coördinate type. It is so constructed that if a straight line called the slope line is drawn through the point A and a parallel line is drawn through the Pressure-Temperature-Total Heat curve B to the vertical Total Heat axis, the three intersections representing quality x (or superheat S), the pressure P (or the corresponding boiling point) and the total heat H will give the correct corresponding values of those properties; that is, the total heat at the given pressure and quality will be read directly. On the same chart two other lines parallel to the first (through A), one from the same pressure on the Pressure-Entropy curve E to the vertical Entropy axis and the other from the same pressure on the horizontal Pressure-Volume line to the vertical Volume axis, will also give directly the values for entropy and for volume. This general characteristic of having points corresponding with each other in a line or in parallel lines gives the name of "Alignment Chart" to this construction.

BASIS OF CONSTRUCTION OF CHART

The construction of this chart is based on the following explanation, which is given in full for the Pressure-Temperature-Total Heat relation only: The curve B is plotted so that for any pressure the horizontal distance, or abscissa, from the Total Heat axis to the point on the curve is equal to the heat of vaporization L, while the vertical distance, or ordinate, of the point above the zero of the Total Heat axis is equal to the heat of the liquid h. Then each point on the vertical quality axis is drawn so that the tangent of the angle of the slope line through it and A is equal to the quality x. Now, if from any point on the Pressure-Temperature-Total Heat curve B a line is drawn parallel to a given slope line, it will intersect the Total Heat axis at a distance above the horizontal line through the pressure point on the curve B equal to the abscissa times the tangent of the angle. Thus, the value of the total heat H is equal to the ordinate representing h plus the product of the tangent of the angle x and the abscissa L; or, $H = h + xL$. The ordinates and abscissas for the Pressure-Entropy curve E are n and $\frac{L}{T}$ respectively, and for the Pressure-Volume line are zero and v. The ordinates of this latter line are zero because the volume of 1 lb. of water is assumed to be zero, in comparison with the volume of steam formed from it.

The range required for volume was so great—since v is 333 cu.ft. at 1 lb., absolute, 38.38 cu.ft. at 10 lb., 8.51 cu.ft. at 50 lb., and 0.76 cu.ft. at 600 lb.—that sufficient accuracy could not be obtained with a single vertical scale similar to the others. A double construction was therefore used, with the lower group of pressures from 1 lb. to 50 lb., and the upper group from 10 to 600 lb. The lower group on the horizontal Pressure-Volume line corresponds to the large graduations on the left-hand side of the Volume axis, and the upper group corresponds to the small graduations on the right-hand side. If it is remembered that the specific volume decreases as the pressure rises, this arrangement will cause no confusion.

As there is no simple way of representing the properties of superheated steam on the basis of an apparent quality greater than unity, or 100 per cent., the following construction was finally chosen: The diagram C for total heat in the Superheated Region was constructed by drawing horizontal lines for pressure at random, and then from actual values of the total heat at these pressures, and for various amounts of superheat, the corresponding slope lines gave intersections through which the curved superheat lines were drawn. The curves for entropy are so near those for total heat that one set was found to represent both of these properties with a very close degree of accuracy. A separate set of curves, however, had to be constructed for volume, and to avoid confusion a second diagram was drawn at D for volume.

SOLUTION OF VARIOUS PROBLEMS, SHOWING THE USE THE CHART

The following problems, worked out in detail, will show the use of the chart and at the same time explain the methods of solving various important questions concerning the generation and use of steam. The values given in parenthesis at the end of each solution are those worked out from the steam tables of Marks and Davis, and are inserted simply for the purpose of showing the accuracy of the determinations made by means of the chart.

1. Find the heat of the liquid, total heat, and latent heat of vaporization of dry steam at atmospheric pressure, 14.7 lb. per sq.in.

Since the quality of water is zero, the slope line through A to the point where $x = 0$ will be horizontal. The corresponding parallel through the value 14.7 on the curve B intersects the vertical Total Heat axis at 180, which indicates that the heat of the liquid is 180 B.t.u. The quality of dry saturated steam is 1.0; so, if a slope line is drawn through A to the point where $x = 1.0$, a parallel to this slope line drawn from 14.7 on the curve B will intersect the Total Heat axis at 1150, which indicates that the total heat of dry steam at 14.7 lb. is 1150 B.t.u. The difference between the two values thus found is 1150 — 180 = 970 B.t.u., which is the latent heat of vaporization required.

(180; 1150.4; 970.4)

2. How much heat is required to make steam at 185 lb., gage, primed 5 per cent., from feed water at 150 deg. F.?

A pressure of 185 lb., gage, is equivalent to approximately 200 lb., absolute, and if the steam is primed 5 per cent., the quality is 95 per cent., or 0.95. To find the total heat in a pound of steam of 0.95 quality and 200 lb. pressure, a slope line is drawn through A to the point where $x = 0.95$, and a parallel to this slope line is drawn through the 200-lb. point on the curve B. The parallel cuts the vertical Total Heat axis at 1160; then the total heat is 1160 B.t.u. The heat in a pound of feed water (which has a quality of $x = 0$) is found by drawing a horizontal line through the 150-deg. point on the curve B. This horizontal cuts the Total Heat axis at 120, indicating that the feed water contains 120 B.t.u. per lb. above 32 deg. The heat required to make 1 lb. of steam, therefore, is 1160 — 120 = 1040 B.t.u.

(1155.9; 117.9; 1038)

3. If steam at 200 lb., absolute, is superheated 250 deg. F., what is the total heat per pound, the actual temperature, and the volume?

As the steam is superheated, the slope line will lie in that part of the chart designated as the Superheated Region. The slope line for finding the total heat is drawn from *A* to the point in the diagram *C* where the horizontal 200-lb. line cuts the 250-deg. cross-line. The parallel is drawn from the point indicating 200 lb. on the curve *B* and cuts the Total Heat axis at 1330; that is, a pound of steam at 200 lb., superheated 250 deg. F., contains 1330 B.t.u. The temperature of saturated steam at 200 lb. is read from the curve *B* directly opposite the point indicating 200 lb. pressure, and is 382 deg. The temperature of the superheated steam is then 382 + 250 = 632 deg. F. The slope line for finding the volume is drawn from *A* to the point in the diagram *D* where the 200-lb. horizontal line cuts the 250-deg. cross-line. A parallel to this slope line, drawn from the 200-lb. point on the horizontal Pressure-Volume line cuts the vertical Volume axis at the point 3.2; that is, the volume of 1 lb. of the superheated steam is 3.2 cu.ft. (If it is remembered that the values on the right-hand side of the Volume axis correspond to the pressures on the upper side of the horizontal Pressure-Volume line, there will be no danger of reading 32 cu.ft. from the vertical Volume axis instead of 3.2 cu.ft.)

(1332.4; 631.9; 3.21)

4. If the steam in problem 2 is passed through a throttling valve and the pressure is reduced to 60 lb., what will be its quality?

Throttling is an action in which the total heat remains constant. According to the solution of problem 2, the point 1160 on the Total Heat axis represents the total heat of the steam before it is throttled. After it is throttled, its pressure is only 60 lb. Therefore, a line is drawn from 1160 on the Total Heat axis to 60 lb. on the curve *B*, and a parallel to this line is drawn through *A*. This parallel through *A*, which is the slope line of the throttled steam, cuts the Quality axis at a point where $x = 0.98$; consequently, the steam after throttling has a quality of 0.98, or contains 2 per cent. of moisture.

(0.978)

5. If a throttling calorimeter, exhausting at 14.7 lb. pressure, has a temperature of 268 deg. F., what is the priming in the steam, if the initial pressure was 150 lb., absolute?

The first step is to find the total heat of the steam. The calorimeter pressure, 14.7 lb., is not shown in the diagram *C* on the chart, and so the heat of superheat must be calculated. The temperature increase is 268 — 212 = 56 deg., and so the heat of superheat is 0.47 × 56 = 26 B.t.u. From problem 1, the total heat at atmospheric pressure is 1150 B.t.u., and so the steam has a total heat of 1150 + 26 = 1176 B.t.u. per lb. Then, from the point 1176 on the Total Heat axis a line is drawn to the 150-lb. point on the curve *B*, and parallel to it a slope line is drawn through *A*. The slope line cuts the Quality axis at 0.98, indicating that the steam is 98 per cent. dry, or contains 2 per cent. of moisture.

(1.9)

6. Find the values of the entropy and volume per pound of the steam in problem 2.

The slope line is drawn to $x = 0.95$, and the parallel is drawn from the 200-lb. point on the Pressure-Entropy curve *E*. This parallel intersects the vertical Entropy axis at 1.5, indicating that the entropy is 1.5. A parallel to the same slope line, drawn from the 200-lb. point on the horizontal Pressure-Volume line, will cut the vertical Volume axis at 2.2, indicating that the volume per pound is 2.2 cu.ft.

(1.4955; 2.175)

7. If the steam of problem 2 expands adiabatically to 2 lb., absolute, what are the values of the final quality, the drop in total heat, the final volume, and the ratio of expansion?

During adiabatic expansion the entropy of the steam does not change. The procedure, therefore, is to find the entropy of the steam at the initial pressure, and using this point on the Entropy axis as a pivot, to swing the parallel to the new pressure, 2 lb., and then to draw a new slope line parallel to the parallel. In the solution of problem 6 the entropy of the steam was found to be 1.5. From the point 1.5 on the vertical Entropy axis a line is drawn to the pressure of 2 lb. on the curve *E*. A slope line through *A* parallel to this line will give a value of $x = 0.76$, or a quality of 76 per cent. Another line parallel to it, from the 2-lb. point on the curve *B*, will cut the Total Heat axis at 870, indicating a total heat of 870 B.t.u.; and a third parallel from the 2-lb. point on the horizontal Pressure-Volume line will cut the vertical Volume axis at 132, indicating a volume of 132 cu.ft. per lb. The total heat of the initial steam, according to problem 2, is 1160 B.t.u., and so the heat drop is 1160 — 870 = 290 B.t.u. The initial volume, by problem 2, is 2.2 cu.ft., and so ratio of expansion is 132 ÷ 2.2 = 60.

(0.757; 289.9; 131.3; 60.2)

8. A closed tank contains 12 lb. of dry steam and 4 lb. of water at a temperature of 300 deg. F. Find the pressure, and the volume of the tank. If the temperature falls to 150 deg. F., find the resulting pressure, and the new quality of the mixture.

The initial mixture consists of 16 lb. of steam and water, of which 12 lb. is steam; so the quality is 12 ÷ 16 = 0.75. The temperature is 300 deg. F., and so the corresponding pressure, read directly from curve *B* opposite 300 deg., is 67 lb. From the 67-lb. point on the horizontal Pressure-Volume line a parallel to a slope line indicating 0.75 quality will cut the vertical Volume axis at 4.9; that is, the volume of the mixture is 4.9 cu.ft. per lb. As the tank contains 16 lb. of mixture, the total volume must be 4.9 × 16 = 78.4 cu.ft. While the temperature falls to 150 deg. the volume remains unchanged, and the pressure falls to 3.75 lb., as the point 3.75 on the pressure side of curve *B* corresponds to 150 on the temperature side. Consequently, from 4.9 on the Volume axis a line is drawn to 3.75 on the horizontal Pressure-Volume line. A slope line through *A* parallel to this line will cut the Quality axis at 0.05; therefore, the quality of the mixture at 150 deg. F. is 0.05.

(67; 78.7; 3.714; 0.05)

Operating Conditions in Diesel Engine Plants

By E. E. Snow

Steam-plant operation may be said to be fairly well standardized. At present there are but few questions of proper steam pressures, vacuum and condensing-water temperatures, as applied to the average steam plant, that have not been solved.

Unfortunately, the reverse is true as regards operating conditions in Diesel-engine plants. Such problems as air-injection pressure, lubrication and cooling-water temperatures are still subjects of discussion. The matter of the temperature of cooling-water discharge is probably the most important. It should be recognized by the operator that the temperature carried must be governed by the character of fuel oil used. In some plants there is a tendency to carry a discharge temperature as low as 120 deg. F., even if the oil is a heavy residuum; in other plants burning a high-gravity distillate, the discharge is often carried at 160 deg. F. It is needless to remind the experienced operator that low temperatures with heavy oils will cause a smoky, foul exhaust. The disadvantage of high temperature with distillate oil is not so generally understood.

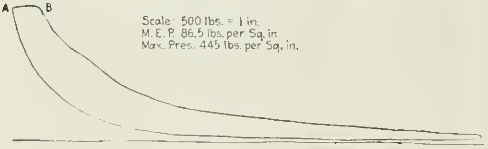


Fig. 1

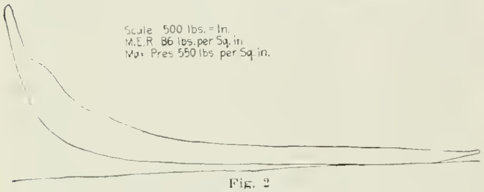


Fig. 2

FIGS. 1 AND 2. DIAGRAMS TAKEN WITH DISCHARGE WATER AT 125 AND 150 DEG. F., RESPECTIVELY

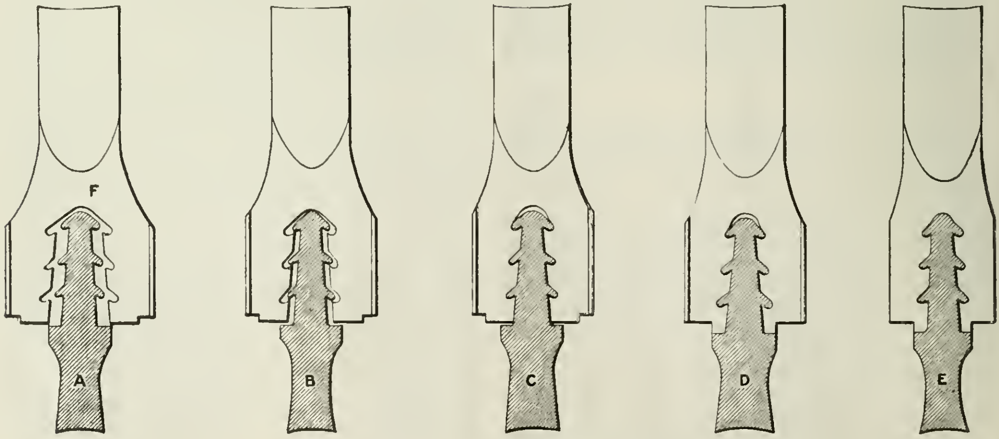
Attention is called to the two indicator cards. Fig. 1 was taken from a Diesel when the cooling-water discharge was 125 deg. F. This card, in respect to the combustion line *AB*, is almost ideal. When the card in Fig. 2 was taken, the temperature of the discharge was allowed to reach 150 deg. F. Since a light distillate was being burned, this high temperature (due to insufficient water) caused the entire cylinder, including the fuel valve, to become hot. The fuel, since it was very thin and volatile, issued from the fuel valve when the latter was opened and immediately the entire charge ignited. This produced a decided rise in pressure above the compression pressure; in many respects this card has the appearance of an Otto-cycle or constant-volume card.

Undoubtedly, this sharp increase in pressure places the engine under a strain not contemplated by the designer. Possibly this high-temperature condition explains an occasional fractured cylinder head or ruined bearing. To all outward appearances the engine was operating under no unusual condition. This is but additional proof that the Diesel engineer needs an indicator and should not neglect to use it nor to learn to analyze what it shows.

Fixing Turbine Blades

A French patent recently granted to the *Aktiebolaget Ljungstroms Angturbro* describes the method of fixing turbine blades and is shown in the accompanying illustrations.

The periphery of the supporting disk, shown cross-hatched in the illustrations, is fashioned with projections as shown, and the bases *F* of the blades are recessed to receive such projections. The recess is initially wide enough to allow the blade to be slipped on over the rim of the disk into the position shown at *A*, and by lateral pressure applied to the base of the disk it is closed successively to the positions and forms shown at *B* and *C*. The shoulder upon the base of the blade is then driven up to the shape indicated by *D*, closing the joint tightly between the shoulder of the disk and the heel of the blade, and a final lateral pressure completes the job, as shown at *E*.



SHOWING METHOD OF SECURING TURBINE BLADES

EDITORIALS

Alcohol as Motor Fuel

INCREASED demands for gasoline with accompanying increase in price have again directed attention to the utilization of substitutes, particularly alcohol, as fuel for internal-combustion motors. The supply of petroleum is limited, and as this limit is approached the price is certain to advance still more, it having doubled during the past six years in this country and more than doubled abroad. On the other hand, the supply of alcohol from vegetable matter is practically inexhaustible, and the sooner it comes into general use for power purposes the longer will the gasoline supply be conserved.

Heretofore the restricted use of alcohol has been due to its inability to compete in price with gasoline, this handicap having been intensified by governmental restrictions. Whether the point has now been reached where successful competition is possible, is a matter for investigation.

The British government, viewing with concern the rising price of gasoline, last November appointed a committee to inquire into the production and utilization of alcohol as a motor fuel. This committee has recently submitted its report. It found that while alcohol is obtainable from molasses, potatoes, wood pulp and other vegetable products, the yield, contrary to popular opinion, is not large; that from potatoes, for instance, being only twenty gallons per ton. It can also be produced synthetically from coal and coke-oven gas, but the most promising source appears to be from tropical plants of which the sun-dried flowers of the mahua tree will yield ninety gallons per ton.

The usability of alcohol in internal-combustion engines with a properly designed carburetor and slightly modified compression is well recognized, so that there is no obstacle from the engineering standpoint. It is purely a commercial problem. Owing to the somewhat lower heat value of alcohol a correspondingly greater quantity must be used per horsepower-hour, so that in order to compete with gasoline the cost per gallon must be proportionately less.

As a means of keeping down the cost the committee recommends that the British government modify the restrictions concerning the storage and distribution of alcohol, consistent with the prevention of its improper use—a recommendation that might well be given serious consideration in this country. It reports further that, while not definitely committed to the idea that the time has arrived when alcohol can compete commercially with gasoline, it believes nevertheless that such time is not far distant and strongly urges that steps be taken by the British government to carry on such investigations and give such support to the alcohol industry as will put it on its feet to meet any further increase in the price of gasoline.

While true that the motor-fuel situation is much more acute in England than in this country, yet would it not be well for this Government to profit by the recommendations of the British committee and by a little forethought through investigation avert a possible crisis a few years hence?

Some eight or ten years ago an effort was made to interest the farmer in the utilization of farm refuse for the production of alcohol on a small scale. To this end certain restrictions were removed, as applied to farms only, and the Department of Agriculture issued instruction pamphlets. The response to this effort, however, was small, perhaps owing to the then low price of gasoline and to the fact that the farmer at that time was not a large user of internal-combustion engines. But that condition has changed, the farmers now have their automobiles and are large users of internal-combustion engines to drive the various farming implements. Perhaps a renewal of the former efforts would now bring results.

Boiler Inspection and Engineers' License in Massachusetts

THE legislature of Massachusetts has consolidated the one hundred and odd commissions and divisions of the state government into twenty departments. The District Police Force, the Board of Boiler Rules, the Board of Elevator Regulations and the Fire Prevention Commission of the Metropolitan District are to be abolished and all their rights, powers, duties and obligations transferred to a Department of Public Safety under the supervision and control of a commissioner appointed by the governor for a term of five years at a salary not to exceed five thousand dollars per annum. The law goes into effect so far as each department is concerned upon the appointment and qualification of the officers having the supervision and control thereof, but not before the first day of December of this year.

The Department of Public Safety is to be organized in three divisions—a division of state police under the immediate charge of the commissioner, a division of fire prevention under the charge of a director to be known as State Fire Marshal, and a division of inspection under the charge of a director to be known as the Chief of Inspection. These directors are to be appointed for three-year terms and to receive such salaries, not in exceses of four thousand dollars per annum each, as the governor and council may determine.

The Board of Boiler Rules is to be reconstituted, to consist of the Chief of Inspection as chairman and four other members appointed by the Commissioner of Public Safety, their qualifications and compensation to be the same as those of the members of the present board.

The functions of the boiler inspection department of the district police, including the examination and licensing of engineers and firemen, are to be exercised by the division of inspections, which will also take over the work of the building inspection department.

To be the chief of the inspection division of a state department of public safety offers a large opportunity for a large man. It would require a high degree of versatility, a broad experience and a comprehensive training to deal in detail with such diversified subjects as the safe design, construction and operation of boilers and pressure vessels and the subjects handled by a building department. The problems are all of an engineering character, and the ideal director would be an engineer of large directive and executive capacity. Even such a man would have to depend largely upon the specialists in the different departments or be swamped in a mass of detail. He should have a keen appreciation of the importance of this trust, a vision of the possibilities of such a department, engineering enough to devise means and prescribe methods for guarding the public safety, and executive ability enough to get them applied. The bill specifies no qualification for the holder of the office, and much will depend upon the good judgment and freedom from political influence of the governor who makes the selection.

Under the new law no provision is made for any head of each of the two subdivisions of the inspection division There is nobody, for instance, between the men who do the actual inspecting of boilers and the examining of engineers and firemen for license and the director who is the head of the building inspection as well. This can be gotten around by detailing an inspector of sufficient experience and ability to do such technical inside work as has brought the department to such a high degree of efficiency under the administration of the present incumbent and his predecessors.

It is unfortunate that the organization as planned is not a permanent one. The work is highly specialized and such that the value and efficiency of the man who is doing it grows with experience and continuity of service. Frequent turnover and uncertainty of tenure are not conducive to economical administration nor to the production of the best results. Work in such a department should offer a man a life's career. One ought to be able to progress from inspector to Chief of Inspections and to Commissioner of Public Safety without fear of disturbance by political changes and without using a large part of his time, energy and interest in keeping his job instead of doing it as it ought to be done.

The success of the new Department of Public Safety will depend upon its personnel. We shall watch its progress with interest.

Interest in Power-Plant Performance

TIME was, not so long ago, when a man's ability to get uninterrupted service from a plant was the highest asset he could attain. This was true of the whole power-plant crew. The fireman who could keep the pointer on the steam-pressure gage at the right figure was a treasure. Those who have had the pleasure of firing a moderate or large power plant remember that the old fellow who was dean in the boiler room commanded the respect of all hands. Of course such a man as "the dean," let us call him, usually secured good performance results measured in terms of coal and water evaporated. But it was because he could keep the pressure up where it belonged that he was admired, just as the engineer who could keep the wheel turning was highly regarded.

The situation in this regard is unchanged today. But more has been added to the requirements of the engineer and his crew. Besides giving uninterrupted service, he must get the most economical performance of which the plant is capable. Today there are indeed many yardsticks by which to measure a plant's performance, considered as a unit and also compared with what other similar well-operated plants can do. As King Alexander's tutor told him there was no royal road to algebra, so, too, must power-plant men understand that there are few if any short cuts to good power-plant performance. To get it requires a knowledge not only of fundamentals and principles, but of the many practical aspects of operation and management, with its market values, and accounting.

The modern power-plant engineer of big proportions must of necessity be much more of a business man than his fellows of yesterday ever dreamed of being.

Engineering Preparedness

SOME time ago *Power* was asked to recommend a man who could keep the power plant in a large factory going. Work was interrupted, production reduced and the force disorganized by frequent shutdowns. We sent them a man who stopped the trouble; not by taking reckless chances in keeping the plant running when another would have shut it down, but by preparedness. He has probably, in thought and in imagination, been through most of the troubles that could possibly occur to mar his record of continuous performance, has foreseen and headed off many, and prepared to grapple with those that he could not prevent.

The first few moments when trouble manifests itself are the critical ones. A masterful man keeps his head, knows just what to do and has things ready to do it with, as though he were expecting it. His crew responds with confidence, bears his coolness and gets out of it with the least fuss and damage. What would you do if:

The water suddenly failed—if the packing blew out of a joint on the steam main—if coal was received for which the grates were not fitted to burn—if the men struck—if the central station solicitor came in—if the boss wanted to know how much it was costing to run the plant—if you had but one feed pump and it broke down—if an engine frame cracked—if the rear arch of a return-tubular boiler fell in during running hours —if the boiler was burned badly—if a blowout pipe became clogged with scale or mud and the boilers had to be kept in operation to prevent a shut-down?

In fact, what would you do in case any of the hundreds of possible accidents that occur in power plants should occur in yours?

Senator Lenroot has introduced a bill to provide for the leasing of coal deposits owned by the United States outside of Alaska. The major condition of any such lease or concession should be that the coal produced be sold to the public at a fair profit upon the actual cost of mining it and that such cost include no interest upon intangibles based upon ownership or privileges under such concession other than expenditures actually made in the obtaining and maintenance of the lease or concession and of the prospecting and other actual work done upon it—in other words, actual cost which involved the expenditure of real time and money.

Plans are under discussion for a great international exposition to be held at Boston to commemorate the three-hundredth anniversary of the Landing of the Pilgrims. It is proposed that the exposition shall be entirely different from the ordinary world's fair, including only the finest exhibits pertaining to science, art, education, religion, industry and commerce.

Correspondence

Loose Bearing Caused Induction Motor To Fail To Start

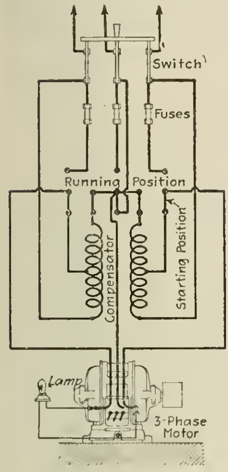


FIG. 1. METHOD OF TESTING FOR OPEN-CIRCUIT

After repairing a large three-phase induction motor, an attempt was made to put it back into service. On closing the compensator switch to the starting position, the motor failed to start, although it was evident from the sound of the machine that it was getting current through its winding. The first thing that suggested itself was an open circuit, so the starting compensator was tested to see if the current was coming through single-phase only. In order to do this quickly, we disconnected the motor lead at the machine, and while the switch was held on the starting position a test lamp was connected across the different leads, as in Fig. 1. This showed current on each phase, at a reduced voltage, of course. We then put the switch on the running position and the test lamp burned brightly across each phase, showing that the motor was getting the current all right.

The rotor seemed to be rubbing a little on the stator, as it was somewhat hard to turn, so the clearance was adjusted by means of two draw-bolts on the bearing housings. This took some time, since when the bearings were moved one way a little, the rotor would bind; then we would shift it back slightly until finally getting it into a position where the rotor turned freely. Another attempt to start motor met with no better result than the first. The next step was to trace out the winding connections, which were found to be apparently correct. The winding being connected two parallel star made it somewhat complicated to trace out. However, by looking to see if the connections went under or over the winding, I would mark an arrow on the group of coils to show the polarity. We went around each phase in this way, starting with the outside lead in each case. The arrows on each group pointed alternately in opposite directions, showing the connections to be correct, as in Fig. 2.

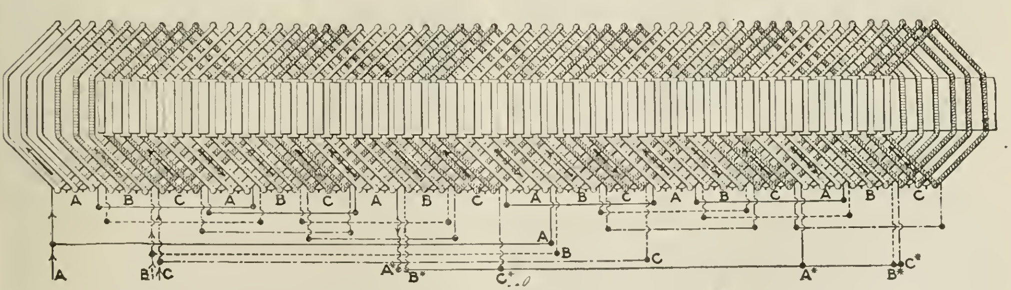


FIG. 2. SIX-POLE, TWO-PARALLEL, STAR-CONNECTED INDUCTION MOTOR WINDING

The next suggestion was to test the polarity of the winding with a compass, when direct current was flowing through the coils. As a source of direct current an automobile starting and lighting battery was pressed into service. The three motor leads, *A*, *B* and *C*, Fig. 2, were joined together and connected to one terminal of the battery. A wire from the other battery terminal was taken to the common or neutral point on the winding, where the three phases connected together, such as A^*, B^* and C^*, Fig. 2. This connection was not attached permanently, as it would have run the battery down, owing to the low resistance of the circuit through the winding, but was attached each time only while the swing of the compass opposite each group was obtained. This test proved the connections to be correct, as the compass needle pointed in opposite directions on alternate groups as it was moved around the winding.

Since the polarity of the coils was undoubtedly correct, it left us all puzzled as to the cause of the trouble, as we had tested for grounds in the winding, open circuit, polarity, tested for the power at the motor terminal, and also mechanically, to see that rotor was free.

We had about decided to give the job up and send the machine to the manufacturers to have it fixed up, when one of the engineers came in on the job and after hearing our story remarked that the motor had given similar trouble, two or three years previous, after being repaired, due to the bearing letting the rotor rub on the stator. This gave us an idea that there might be a slight looseness in the bearing, sufficient to let the rotor lift up and rub on the stator. Acting on this, the bearing bolts were adjusted until the rotor would just clear the bottom of the stator. This proved to be the source of all the trouble; on closing the compensator the motor started up and ran satisfactorily greatly to the relief of everybody concerned.

Toronto, Ont., Canada. H. WILSON.

Needed Improvements in Boiler Construction

The account in your issue of Mar. 25, 1919, of a double boiler explosion at Mobile and the more recent one at Newmarket, Ont., brings to mind some opinions that I have held for many years. In a paper that I read before the American Society of Mechanical Engineers[1] a few years ago, I took the ground that the spherical heads of steam drums should not be given much credit for strength and that they should be stayed by radial gusset plates strong enough to take the whole load. A way to do this is shown in Fig. 1. The reason for this view is that the stresses in these heads at the edges cannot be computed, that they are not wholly in a state of equilibrium and that they therefore "breathe" and tend to disintegrate and crack along the edges. The disintegration promotes corrosion. Any insurance company will testify to numerous cases of partial injury around the edges of drumheads, and from the many cases of rupture it seems to me that it is time that drumheads should be considered dangerous unless they are stayed like flat heads.

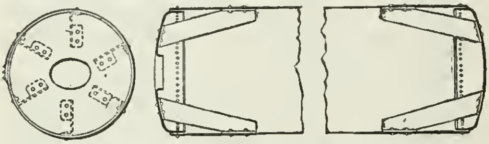


FIG. 1. DRUM HEADS STAYED BY RADIAL GUSSET PLATES

Many designers of steam boilers appear to think that if they put a spherical head in a drum having a radius equal to the diameter of the drum, a thickness equal to or greater than that of the drum shell and a fairly good-sized radius at the corner, they have done their duty. I do not think that they have and believe that they should discontinue the practice. I should much prefer heads of suitable thickness dished inward, although nobody uses them. There is no more reason for being afraid of them than for being afraid of corrugated furnaces, nor, in fact, so much. It should not be forgotten that the manhole openings are a serious cause of weakness and that sometimes they have been pushed out.

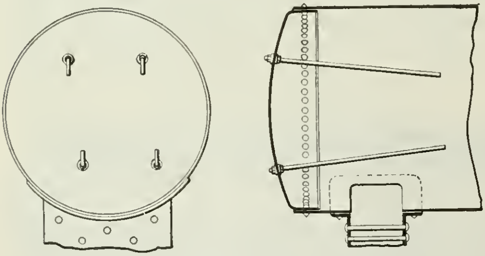


FIG. 2. TRANSVERSE HEADER CONNECTION TO LONGITUDINAL DRUM

In my opinion there are several partly digested features of water-tube boilers, and among them are the manners in which drums and headers are cut into for various purposes. A designer should carefully consider whether any part of his design can move back and forth with changes in pressure. Changes in pressure are very frequent, and if any part can bend with such changes, a potential cause of rupture exists.

If a transverse header is connected to a longitudinal drum so as to considerably cut the latter off, as shown in Fig. 2, there is likely to be a rupture, even if there are longitudinal ties riveted to the shell, for they may not be firmly riveted and no dependence should be placed upon them. Neither should any dependence for making up this strength be placed upon stay-bolts of the water-leg being placed close to the drum. Longitudinal tie-rods should not be used because they may not take their load until after the drum has been overstressed from the steam pressure acting on the ends of the drum.

The best way to provide communication is to penetrate the drum by the smallest practicable number of small holes, or to make some with flanges and pressed inward, as shown in Fig. 3, as is done in one make of water-tube boiler. Better still, longitudinal drums should be abandoned and cross-drums used.

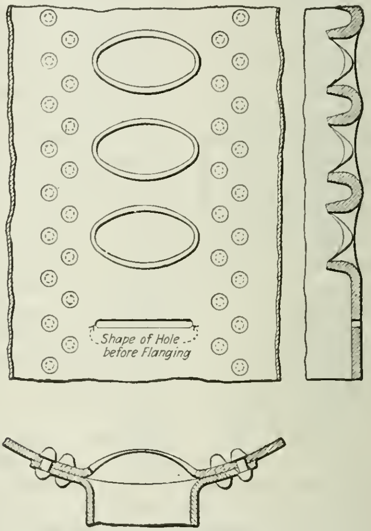


FIG. 3. SMALL HOLES PRESSED TO LARGE FLANGE OPENINGS

A feature of many of the designs of cross-drum marine water-tube boilers is the cutting of many holes in the drum for accommodating a row of nipples at the bottom and one or two rows of circulating tubes on the side. When this is done, it is common to rivet on a reinforcing strap inside, like *A*, Fig. 4. This strap should, however, always be riveted to the outside of the drum like *B*, and be made a metal-to-metal contact with it if such a thing is possible in the art of boiler-making.

The tube holes in the strap should be larger than those in the drum, and the tubes should be expanded only in the drum plate. It is necessary to design the outside strap with the outer rivets far apart in order to have a joint of high efficiency, and to do this and be able to calk the strap it is necessary to resort to the saw-tooth joint. If the strap is placed on the inside, pressure will get between it and the drum if it is not calked and probably if it is, and it becomes a series of bent ties between rivets and never can help the main plate until the latter is overstrained. If the outside strap could be used without calking, it would be more effective, and this can be done if the rivets are reliably calked inside. If pressure gets between plates the inside one, even if it is the shell, is thrown out of equilibrium and bends between rivets.

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[1] "Transactions A. S. M. E." Vol. 37, p. 627.

Better still, however, drums should be so thick that they will not require reinforcing where penetrated, and the longitudinal joints should be placed where they will not be penetrated. In such construction the longitudinal joint would generally be one of low efficiency; possibly it would be a single-riveted double-strap butt joint.

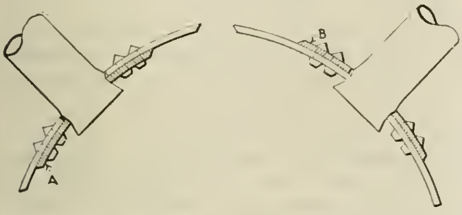

FIG. 4. INSIDE REINFORCING STRAP A WRONG

Here again, as many times before, I want to advocate the abandonment of the prevailing form of butt joint used in the country namely, that of having a wide inside, like *B*, Fig. 5, in order to minimize bending and Such a joint means bending of plates, with variations in pressure, and such alternate bending may mean explosions. While joints with straps of equal widths and all rivets in double shear should always be used, if the one-sided joint is used the wide strap should be outside, like *B*, Fig. 5 in order to minimize bending and promote the effective assumption of the load. In this case it would be an easy matter to calk both the inside strap and the rivets and leave the outside strap uncalked.

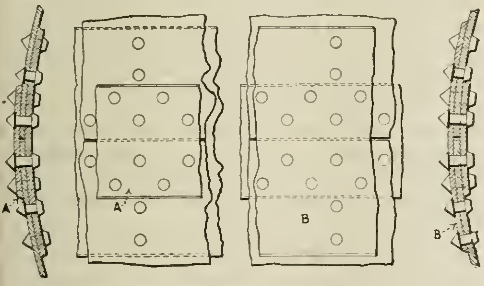

FIG. 5. NARROW OUTSIDE STRAP A MEANS BENDING OF MAIN PLATES

Everything should be done to prevent any part of a boiler from bending, and this is a principle that every designer should keep constantly in view. When a boiler is designed so that this principle is realized and good material and workmanship are employed, explosions will all but disappear, and this is the moral of this letter.

The motto of the boiler designer should be, "Avoid transverse stresses, especially if they are alternating."

Boston, Mass. F. W. DEAN.

Reclaiming an Old Heating System

In a plant that I recently visited, I found a very unusual improvement in operation on a vacuum heating system. This plant consisted of several widely scattered buildings of varying heights and types of construction. The system in use took the exhaust steam from the main engines through the radiators into the return lines, through common globe valves instead of automatic vacuum valves. These valves were left wide open to be sure that no water stayed in the coils and this, together with long, leaky return lines, made it impossible for the vacuum pump to do good work without adding an excessive amount of cold water to condense the steam, which was later thrown away, as it could not be used.

As the chief engineer could not get an appropriation to put in about 200 return valves and renew the return lines, which would have cost close to $2000, he did the next best and obtained authority to buy a closed heater, which he did. This heater was connected to the main return line near the pump so that the returns would occupy the regular steam space. The feed water for the boilers passed through the coils, then to the main heater. With water from the city mains at from 45 to 60 deg., a 5-in. vacuum was easily maintained by this heater surface condenser without the addition of cold water.

While at first glance this appears to be a crude roundabout way of accomplishing an object, there are several advantages: First, a good active circulation in the heating system is assured; second, there is a saving in heat and water, as no cooling water is added to be thrown away; third, cold water entering this heater leaves at from 70 to 110 deg., going to the main heater, where it is heated to a temperature never before attained and resulting in a marked saving in coal; fourth, by sending warm water into the coils of the main heater instead of the icy water of former years, there is much less condensation on the coils and consequently the heating system receives much drier steam.

Instead of an outlay of from $1500 to $2000 and much disturbance throughout the buildings, this method cost about $500 with no disturbance and a marked improvement in boiler efficiency. H. K. WILSON.

New Bedford, Mass.

Peening Stopped Leak

Recently, when about to brush the tubes of a boiler a steam leak was discovered at the joint of the front 12-in. nozzle. An examination showed that the leak was at the threaded joint.

Although the pressure carried never exceeds 80 lb., the leak, if neglected, would have grown worse, therefore I suggested putting in a new nipple. This would have entailed considerable expense, as all the joints to and including the one at the main are screwed. The department inspector sent a steamfitter to look into the matter. He told me he would first try peening on the inside as a remedy before resorting to a more radical measure. This was done by using a light ballpeen hammer on the joint on the inside, for fully two hours.

The boiler was used eight months this last winter with no sign of a leak. A. DOLPHIN.

Jamaica, N. Y.

Don't Take Chances with the Synchronoscope

On page 650 of *Power*, May 29, Mr. Gillooly wrote about taking chances with synchronoscopes. Further comments on this practice may be of interest, since the subject is an important one and one about which there is comparatively little in print.

Synchronoscopes should always be checked before use. If all connections are correct and the synchronizing plug is inserted, the instrument pointer invariably gives a kick. Synchronizing lamps are generally used as well as a synchronoscope, and the indication and functioning of the former should be watched in conjunction with the synchronoscope.

Failure of any of the lights to burn indicates a burnt-out lamp or an open circuit. If the lights operate correctly while the synchronoscope does not, it is often safe to synchronize by the lamps, provided the man doing the synchronizing is familiar with the speed at which the switches operate, the characteristics of the machines and the system upon which it operates.

The writer investigated one job where it was impossible to synchronize by the synchronoscope, and it was found that the instrument pointer was 180 deg. out of phase. Watching the lamps after checking up the instrument wiring brought the true state of affairs to light. In choosing between synchronizing with lamps out or at full brilliancy, the former will be found the more preferable, as it permits of closer judgment by the eye.

To synchronize two alternating-current machines for minimum current flow at time of tying the machines together, there must be equality of terminal voltage between the machines, they must be operating at the same frequency, and they must be in phase. The synchronoscope indicates the latter quite accurately, but some instruments are not very sensitive to voltage difference. While voltage difference is the least important of the three requirements for synchronizing, nevertheless terminal voltage should be checked before paralleling the units.

Failure of synchronoscopes to work is generally due to broken wires, the instrument sticking, blown transformer fuses at the instrument's transformers, burnt-out lamps or lamps loose in their sockets. Faulty synchronizing plugs sometimes give trouble and cause delay.

There are several good schemes in use for utilizing the synchronoscope in certain special ways. Sometimes generators are protected by overload relays only during the time that the machines are being synchronized. In this way a machine is protected against bad synchronizing. This is easily accomplished by connecting the overload trip circuit through the synchronizing plugs, so that the circuit that trips the oil switch is energized through the overload relays only while the synchronoscope plugs are in circuit.

Another practice that is sometimes employed in stations having a large number of machines is to wire the control circuit for closing the generator circuit-breaker so that it cannot be closed unless the synchronizing plug is in the receptacle corresponding to the generator to be synchronized. In this way a station attendant cannot start to synchronize one machine and by mistake close the circuit-breaker of some other machine that is standing idle. B. M. SMITH.

Cicero, Ill.

Making Each Coil of An Ammonia Condenser Do Its Share

In the May 27 issue under the heading, "Making Each Coil of Ammonia Condenser Do Its Share," A. G. Solomon has an interesting and valuable article. I have for the last two years been experimenting along the lines suggested by Mr. Solomon. In regulating the water to the double-pipe condenser, the efficiency has been surprisingly increased by maintaining as nearly as was possible a uniform supply of water to the condenser.

I have also observed a few changes that have a serious effect on the efficient operation of the refrigeration plant. Sometimes, shortly after the supply valves to the separator condensers have been set, the rise in temperature of the outside atmosphere will have its effect on the operation; and also, any change in the water pressure in the main supply pipe (particularly when the pressure is reduced) will have a serious effect on the efficient operation of a refrigeration plant. A change in pressure is liable to take place shortly after the valves have been set.

The plant I have experimented with receives its supply from the city mains where the pressure varies from 50 to 60 lb. and by installing a pressure-reducing valve adjusted to maintain a uniform pressure of 40 lb. it was possible to greatly improve the operating conditions. By operating under the automatic regulation of pressure, the valve can be set to supply the condensers and it is not necessary to make any change in resetting the valves unless there is a marked changed in the temperature of the atmosphere or water supply.

Buffalo, N. Y. T. SUTCLIFFE.

Flywheel Explosion at St. Louis

Mr. Dixon's remarks on page 699 of the May 6 issue, regarding the flywheel explosion in a rolling mill, is of interest to me, as I was employed in the mill at the time the engine was first erected and started. As he states, it was an automatic cutoff type and ran as such for a short time after it was put in operation. Trouble with the governor soon developed, however. One evening, just at the time of changing the shift, was, I believe, the first time it ran away. I was standing at my locker door. Everything was serene, when the engine began to race and the throttle was reached barely in time to avert disaster.

From that time on, during my connection with the engine, we ran it on the throttle altogether. I was in no position of authority at the time, but being curious as to why the governor should act the way it did, I wrote to the manufacturers of the engine for a book of instructions. On checking up the valve and governor setting, I found that the governor mechanism was assembled in the wheel, in the position it should have been for running in the opposite direction, which explained its action. The master mechanic in charge at that time had a very decided mind of his own, so my partner and I thought it better to let the engine run the way it was than to start an argument. I am sure that if changes had been made the engine would have operated satisfactorily on its original governor. The throttling governor and shaft pulley Mr. Dixon speaks about were added after I left the plant. J. A. WATKINS.

Jefferson City, Mo.

Inquiries of General Interest

Inch of Water and Pressure per Square Inch—What is the value of an inch of water pressure expressed in pounds or ounces per square inch? W. D. J.

The pressure exerted per inch of depth of an incompressible liquid is the same pressure per square inch as the weight of a cubic inch of the liquid. A cubic foot of water at standard temperature (62 deg. F.) weighs 62.355 lb., and assuming water to be incompressible, an inch of water pressure is equal to 62.355 ÷ 1728 = 0.03609 lb. per sq.in., or 0.03609 × 16 = 0.5774 oz. per square inch.

Calculating Power Factor—How is the power factor figured from the meter readings of a three-phase alternator? The voltmeter reads 550, the ammeters 360 and the wattmeter 260 kilowatts. M. D.

The kilovolt-amperes (kv.-a.) in a three-phase circuit equals volts × amperes × 1.732 ÷ 1000, in this problem equals 550 × 360 × 1.732 ÷ 1000 = 342.9. Power factor

$$= \frac{\text{kilowatts}}{\text{kilovolt-amperes}} = \frac{260}{342.9} = 0.76.$$

Water Discharged by Blowing Down 1½ In.—What quantity of water is discharged from blowing a 72 in. dia. × 18 ft. horizontal return tubular boiler 1½ in. from a water level 17 in. below the under side of the shell? P. E. M.

The cross sectional area of the steam space may be found by the approximate formula for the area of a segment of a circle, namely,

$$\textit{Area of segment} = \frac{4H^2}{3}\sqrt{\frac{2R}{H} - 0.608}$$

where H = the height of segment and R = the radius of arc. When the height of the steam space is 17 in. and 2 R is equal to 72 in., by substitution in the formula the cross sectional area of the steam space would be

$$\frac{4 \times 17 \times 17}{3}\sqrt{\frac{72}{17} - 0.608} = 733.9 \textit{ sq.in.}$$

and when the height is 1½ in. lower, or 18½ in. below the sectional area of the steam space would be

$$\frac{4 \times 18.5 \times 18.5}{3}\sqrt{\frac{72}{18.5} - 0.608} = 862.9 \textit{ sq.in.}$$

Hence the cross sectional area of the water discharged would be 826.9 − 733.9 = 93 sq.in. and for 18 ft. length of shell, the volume of water discharged would be 93 ÷ 144 × 18 = 11.62 cu.ft.

The weight of water discharged would depend on its temperature. If the boiler pressure was 100 lb. per sq.in., the temperature would be 338.1 deg. F. At that temperature water has a density of 54 lb. per cu.ft. and the weight of water discharged would be about 11.62 × 54 = 627.48 lb.

Setting Slide Valve With Lead—What is the method of setting the valves of an upright slide-valve engine and how much lead should there be? D. M.

The method is practically the same as for setting the valve of a horizontal slide-valve engine. Remove the steam-chest cover and, with the eccentric fast on the shaft, turn the engine over by hand and find whether the admission edge of the valve overrides the admission edge of the steam port as much for one end of the cylinder as for the other. If the amounts are not the same, they should be equalized by adjustment of length of the valve rod. Then place the engine on a center and set the eccentric to such a position that the valve will give the desired lead opening at the beginning of the stroke, but with the eccentric so placed with reference to the crank that the opening will be increased by turning the engine in the running direction. Next, place the engine on the opposite center and if the lead is not the same, obtain one-half the desired lead by readjustment of the valve rod and one-half by readjustment of the eccentric, repeating these adjustments on one end and then the other until the lead is equalized. The appropriate amount of lead opening depends on the size, design and speed of the engine, and also on the steam pressure and the load to be carried. The lead should be at least enough to obtain full steam-chest pressure in the cylinder at the beginning of the stroke when the engine is running at normal speed, and also as much as may be necessary, in conjunction with compression of the exhaust, to insure sufficient cushioning of the piston for quiet running of the engine.

Reversing a Compound-Wound Interpole Motor—We have a 40-hp. 220-volt compound-wound interpole motor with the armature series-field and interpole windings connected in series and do not see any provision made for reversing the direction of rotation of this machine. What connection should be changed to give a reverse direction of rotation? W. L.

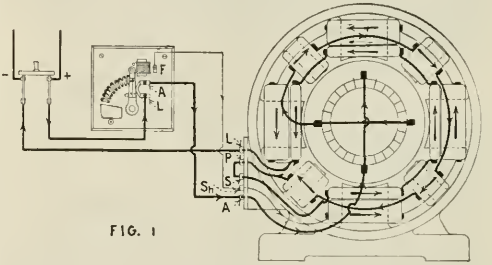

FIG. 1

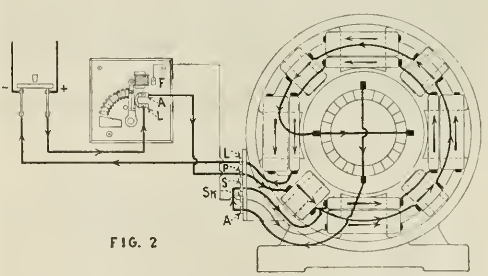

FIG. 2

The direction of rotation of any interpole motor may be changed by reversing the direction of the current through both the armature and interpole windings. If Fig. 1 is the correct connection to give a compound-wound interpole motor one direction of rotation, the connections Fig. 2 are correct for the opposite direction of rotation. It will be seen that the current in the armature and interpole windings in Fig. 2 is flowing in an opposite direction from that in Fig. 1, which was accomplished by interchanging the external wires to the interpole terminal P and the armature terminal A. If the machine is shunt wound, it is generally more convenient to interchange the shunt-field connections to obtain a reverse direction.

The Computation of Combustion Data[*]

By ARTHUR D. PRATT
Assistant to the Advisory Engineer, Babcock & Wilcox Company, New York City

The methods of computing combustion data and the widely differing data resulting from the combustion of different classes of fuel—that is, the wide variation in possible or probable flue-gas analyses, products of combustion and air supplied per pound of fuel for different combustion conditions—are best illustrated by examples, and these are given.

TYPICAL examples of the different classes of fuel used for the commercial production of heat under steam boilers are considered in the following. Excepting in the case of coal where the analyses vary over a wide range, the analyses of the fuels taken are sufficiently near an average to allow the results to be plotted in such manner that for a given flue-gas analysis (per cent. CO_2) the weight of the products of combustion and the amount of excess air corresponding to such analysis may be determined directly for the specific class of fuel considered with a degree of accuracy sufficient for approximate work.

Mr. Pratt refers several times to the formulas given in what follows:

Formula (4) (Dulong's):

$$B.t.u.\ per\ lb. = 14{,}600\,C + 62{,}000\left(H - \frac{O}{8}\right) + 4050\,S$$

The symbols represent proportionate parts by weight of carbon, hydrogen, oxygen and sulphur in the fuel; coefficients represent approximate heating values of the constituents with which they appear in the formula.

Formula (27):

$$Pounds\ dry\ gas\ per\ pound\ carbon = \frac{11\,CO_2 + 8\,O_2 + 7\,(CO + N_2)}{3\,(CO_2 + CO)}$$

The symbols represent proportionate parts by volume of constituents of gas.

Formula (28):

$$Dry\ air\ supplied\ per\ pound\ C = \frac{3.032\,N_2}{CO_2 + CO}$$

The symbols represent volumetric percentages; 3.032 is a constant.

Given a coal having the following ultimate analysis: Carbon, 79.86 per cent.; hydrogen, 5.02 per cent.; oxygen, 4.27 per cent.; nitrogen, 1.86 per cent.; sulphur, 1.18 per cent.; ash, 7.81 per cent.; moisture, 2.90 per cent.; B.t.u., per pound, 14,351.

With perfect combustion the oxygen and air required, and the products of combustion per pound of coal, will be as in Table I.

TABLE I. PRODUCTS OF COMBUSTION AND AIR REQUIRED FOR COAL

	Wright per Pound Coal, Pounds	Required Pounds		Products of Combustion Pounds per Pound Coal				
		O_2	Air	CO_2	O_2	N_2	H_2O	SO_2
C	0.7986	2.130	9.200	2.929	.....	7.070	..	....
H_2	0.0502	0.402	1.735	..	....	1.333	0.452	....
O_2	0.0427	.....	.....	....	0.043	.....	..	..
N_2	0.0186	....	......	.....	....	0.019	....	...
S	0.0118	0.012	0.051	.	....	0.039	.....	0.024
Ash	0.0781	.....	......	.	.....	.....	.....	....
	1.0000	2.544	10.986	2.929	0.043	8.461	0.452	0.024
O_2 in Coal.....		0.043	0.186*	.....	0.043	0.143*	.....	.....
		2.501	10.800	2.929	0.000	8.318	0.452	0.024
SO_2 as CO_2....		.....	.....	0.024	.....	.....	.....	0.024
		2.501	10.800	2.953	0.000	8.318	0.452	0.000

*Air and N_2 equivalents of O_2 in coal.

The weight of air theoretically required for the combustion of one pound of coal is then 10.800 lb. For each 20 per cent. in excess of this amount (each 2.160 lb. above 10.800) there will appear in the products of combustion 2.160 × 0.2315 = 0.500 lb. O_2 and 2.160 × 0.7685 = 1.660 lb. N_2, and the weights of the products of combustion per pound of coal for varying amounts of excess air will be as given in Table II.

TABLE II. WEIGHTS OF PRODUCTS OF COMBUSTION OF COAL

	Weight Products Perfect Combustion	Weight Products—Varying Amounts of Excess Air—Pounds				
		20 Per Cent.	40 Per Cent.	60 Per Cent	80 Per Cent.	100 Per Cent.
CO_2	2.953	2.953	2.953	2.953	2.953	2.953
O_2	0.000	0.500	1.000	1.500	2.000	2.500
N_2	8.318	9.978	11.638	13.298	14.958	16.618
H_2O	0.452	0.452	0.452	0.452	0.452	0.452
	11.723	13.883	16.043	18.203	20.363	22.523

Expressed in terms of percentage weight, these values are given in Table III.

TABLE III. PERCENTAGE WEIGHT, PRODUCTS OF COMBUSTION OF COAL

	Per Cent. Weight Products Perfect Combustion	Per Cent. Weight Products—Varying Amounts of Excess Air				
		20 Per Cent.	40 Per Cent.	60 Per Cent.	80 Per Cent.	100 Per Cent
CO_2	25.190	21.270	18.407	16.233	14.502	13.111
O_2	0.000	3.602	6.233	8.240	9.821	11.100
N_2	70.955	71.872	72.543	73.054	73.458	73.782
H_2O	3.855	3.256	2.817	2.483	2.219	2.007
	100.000	100.000	100.000	100.000	100.000	100.000

Expressed in terms of percentage weight of dry products of combustion these values are as given in Table IV.

TABLE IV. WEIGHT OF DRY PRODUCTS OF COMBUSTION OF COAL, PER CENT.

	Per Cent Weight Dry Products Perfect Combustion	Per Cent. Weight Dry Products—Varying Amounts of Excess Air				
		20 Per Cent.	40 Per Cent.	60 Per Cent.	80 Per Cent.	100 Per Cent.
CO_2	26.200	21.987	18.940	16.636	14.831	13.380
O_2	0.000	3.723	6.414	8.450	10.044	11.327
N_2	73.800	74.290	74.646	74.914	75.125	75.293

If we convert these percentages by weight of the dry products of combustion into terms of percentage by volume, the values in Table IV become as given in Table V.

TABLE V VOLUME OF DRY PRODUCTS OF COMBUSTION OF COAL

	Per Cent. Volume Dry Products Perfect Combustion	Per Cent. Dry Volumes—Varying Amounts of Excess Air				
		20 Per Cent.	40 Per Cent.	60 Per Cent.	80 Per Cent.	100 Per Cent.
CO_2	18.428	15.285	13.057	11.396	10.110	9.085
O_2	0.000	3.559	6.080	7.960	9.415	10.575
N_2	81.572	81.156	80.863	80.644	80.475	80.340
	100.000	100.000	100.000	100.000	100.000	100.000

For the purpose of comparing the results as computed with those obtained through the use of the combustion formulas that have been discussed, assume that the coal is burned with 40 per cent. excess air and the flue-gas analysis by volume shows 13.057 per cent. CO_2, 6.080 per cent. O_2 and 80.683 per cent. N_2.

The weight of dry products of combustion per pound of carbon will be, from formula (27):

$$\frac{11 \times 13.057 + 8 \times 6.080 + 7 \times 80.863}{3 \times 13.057} = 19.359\ lb.$$

Multiplying this value by the weight of carbon per pound of dry coal, we have as the weight of dry products per pound of dry coal,

$$19.359 \times 0.7986 = 15.460\ lb.$$

as against a value, in Table I, of

$$16.043 - 0.452 = 15.591\ lb.$$

an error of 0.131 lb., or 0.84 per cent. If the carbon weight is corrected for the sulphur equivalent (explained on page 54 of the book), the value of C becomes

$$0.7986 + (0.012^1 \div 1.833) = 0.8051$$

and the weight of the dry products of combustion per poun of dry coal becomes

$$0.8051 \times 19.359 = 15.586\ lb.$$

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[*] From Mr. Pratt's new book, "Principles of Combustion in the Steam Boiler Furnace," by permission of the Babcock & Wilcox Co.

which checks with the value of Table I within 0.03 per cent.

The total weight of gas per pound of coal fired will be the sum of the dry products per pound of dry coal, the water vapor from the hydrogen and the weight of moisture per pound of coal, or

$$15.591 + 0.452 + 0.029 = 16.072\ lb.$$

The weight of dry air supplied per pound of carbon, from formula (28) will be

$$\frac{3.036 \times 80.863}{13.057} = 18.802\ lb.$$

The weight of dry air supplied per pound of coal, using the actual carbon weight, will be

$$18.802 \times 0.7986 = 15.015\ lb.$$

while the weight using the carbon weight corrected for the sulphur equivalent (in this case the ratio of the nitrogen in the air supplied for the combustion of carbon and sulphur to CO_2 and SO_2 respectively) will be

$$18.802 \times [0.7986 + (0.012 \div 2.667)] = 15.100\ lb.$$

The actual weight of air supplied per pound of dry fuel will be the total products of combustion per pound of dry coal less the weight per pound which is burned and appears in such products, or, from Table I and the weight of ash as given by the analysis:

$$16.043 - (1 - 0.078) = 15.121\ lb.$$

For this particular coal then, the foregoing errors, using the uncorrected and the corrected values of carbon as applied to formula (28), are 0.070 per cent. and 0.14 per cent. respectively.

Formulas (28), (28a) and (28b) will, as stated, give results within reasonably accurate limits, with fuels having a low nitrogen content, the error varying with the percentage of nitrogen and with the amount of air used for combustion. With fuels of high nitrogen content, the error may be as great as 80 to 90 per cent. (see blast-furnace gas), and for such fuels these formulas are not to be relied upon.

The heat of combustion per pound of dry coal computed from formula (4) will be

$$14600 \times 0.7986 + 62000\ (0.1502 - \frac{0.0427}{8}) +$$
$$4050 \times 0.0118 = 14{,}492\ B.t.u.$$

as against the calorimetrically determined value, 14,351 B.t.u., an error of 0.99 per cent.

To indicate the amount of possible error with high-sulphur fuels, in the determination of the dry products of combustion per pound of fuel from formula (27) where the carbon content is not corrected for the sulphur equivalent, let us assume a coal having the analysis given below. The weight of oxygen and air theoretically required, and the weight of the products of perfect combustion per pound of dry coal will be as in Table VI.

TABLE VI. WEIGHT OF OXYGEN AND AIR REQUIRED FOR COAL PRODUCTS OF PERFECT COMBUSTION

	Weight per Pound Coal, Pounds	Required—Pounds		Products of Combustion—Pounds per Pound Coal				
		O_2	Air	CO_2	O_2	N_2	H_2O	SO_2
C	0.6125	1.6335	7.0560	2.2460	. .	5.4275		
H	0.0448	0.3584	1.5483	. . . . .		1.1698	0.4032	
O_2	0.1062	. . . . .	. . . . . .		0.1062	.		
N_2	0.0100	. .	. . . . . .	. .	. . .	0.0100		
S	0.0442	0.0442	0.1909	. . . .	. . .	0.1467		0.0884
Ash	0.1823	. . . . . .	. . . . . .	. . . . . .	. .		.	.
		2.0361	8.7952	2.2460	0.1062	6.7690	0.4032	0.0884
O_2 in coal		0.1062	0.4588	. . . .	0.1062	0.3526		
		1.9299	8.3364	2.2460	0.0000	6.4164	0.4032	0.0884
SO_2 as CO_2 .		. . .		0.0884	. . . .		. .	0.0884
		1.9299	8.3364	2.3344	0.0000	6.4164	0.4032	0.0000

The air required per pound of dry coal for perfect combustion is thus 8.3364 lb. If we assume the coal to be burned with 20 per cent. excess air, there will appear in the products of combustion, in addition to the weights just given, $1.6673 \times 0.2315 = 0.3860$ lb. O_2 and $1.6673 \times 0.7685 = 1.2813$ lb. N_2. With 20 per cent. excess air, then, the weight of the products of combustion per pound of dry coal, these weights expressed in terms of percentage weight, expressed in terms of percentage weight of dry products, and expressed in terms of percentage volume of dry products, are as follows:

	Weight Products, Pounds	Per Cent Weight Products	Per Cent Weight Dry Products	Per Cent Volume Dry Products
CO_2	2.3344	21.572	22.407	15.603
O_2	0.3860	3.567	3.705	3.547
N_2	7.6977	71.135	73.888	80.850
H_2O	0.4032	3.726	.	
	10.8213	100.000	100.000	100.000

Under the assumed conditions, the weight of dry gas per pound of carbon will be from formula (27):

$$\frac{11 \times 15.603 + 8 \times 3.547 + 7 \times 80.850}{3 \times 15.603} = 16.3635\ lb.$$

Multiplying the value by 0.6125, the weight of carbon per pound of dry coal, we have as the dry products per pound

$$16.3635 \times 0.6125 = 10.022\ lb.$$

as against the computed value above,

$$10.8213 - 0.4032 = 10.418\ lb.,$$

an error of approximately 4 per cent. If, on the other hand, the weight of carbon is corrected for the sulphur equivalent, we have

$$16.3635 \times (0.6125 + (0.0442 \div 1.833)) = \mathbf{10.417}\ lb.,$$

which value checks with the computed weight.

CALCULATIONS FOR FUEL OIL

Given an oil having an ultimate analysis as follows: Carbon, 84 per cent.; hydrogen, 12.7 per cent.; oxygen, 1.2 per cent.; sulphur, 0.4 per cent.; nitrogen, 1.7 per cent.

With perfect combustion the oxygen and air required per pound of oil, and the products of combustion per pound will be as in Table VII.

TABLE VII. AIR REQUIRED FOR COMBUSTION OF OIL—PRODUCTS OF COMBUSTION

	Weight per Pound Oil, Pounds	Required—Pounds		Products of Combustion—Pounds per Pound of Oil				
		O_2	Air	CO_2	O_2	N_2	H_2O	SO_2
C	0.8400	2.240	9.677	3.080		7.437		
H	0.1270	1.016	4.389			3.373	1.143	
O_2	0.0120				0.012			
S	0.0040	0.004	0.017			0.013	.	0.008
N_2	0.0170					0.017		
		3.260	14.083	3.080	0.012	10.840	1.143	0.008
O_2 in oil.		0.012	0.052*		0.012	0.040*		
		3.248	14.031	3.080	0.000	10.800	1.143	0.008
SO_2 as CO			.	0.008	.			0.008
		3.248	14.031	3.088	0.000	10.800	1.143	0.000

*Air and N_2 equivalents of O_2 in oil.

The weight of air theoretically required for the combustion of one pound of oil is, then, 14.031 lb. For each 20 per cent. supplied in excess of this weight of air (each 2.8062 lb. above 14.031), there will appear in the products of combustion $2.8062 \times 0.2315 = 0.6996$ lb. O_2 and $2.8062 \times 0.7685 = 2.1566$ lb. of N_2, and for varying amounts of excess air the weights of the products of combustion per pound of oil will be as given in Table VIII.

TABLE VIII. WEIGHT OF PRODUCTS COMBUSTION OF OIL WITH VARYING EXCESS AIR

	Weight Products Perfect Combustion	Weight Products—Varying Amounts Excess Air Pounds				
		20 Per Cent	40 Per Cent.	60 Per Cent.	80 Per Cent	100 Per Cent
CO_2	3.088	3.088	3.088	3.088	3.088	3.088
O_2	0.000	0.650	1.299	1.949	2.598	3.248
N_2	10.800	12.957	15.113	17.270	19.426	21.583
H_2O	1.143	1.143	1.143	1.143	1.143	1.143
	15.031	17.838	20.643	23.450	26.255	29.062

Expressed in terms of percentage weight, these values are as given in Table IX.

TABLE IX. PERCENTAGE WEIGHT OF PRODUCTS OF COMBUSTION OF OIL

	Per Cent Weight Products Perfect Combustion	Per Cent Weight Products—Varying Amounts Excess Air				
		20 Per Cent.	40 Per Cent.	60 Per Cent.	80 Per Cent.	100 Per Cent.
CO_2	20.544	17.311	14.959	13.169	11.762	10.626
O_2	0.000	3.644	6.293	8.311	9.895	11.176
N_2	71.852	72.637	73.211	73.646	73.990	74.265
H_2O	7.604	6.408	5.537	4.874	4.353	3.933
	100.000	100.000	100.000	100.000	100.000	100.000

Expressed in terms of percentage weight of dry products of combustion these values are as given in Table X.

TABLE X. PERCENTAGE WEIGHT DRY PRODUCTS OF COMBUSTION OF OIL

	Per Cent Weight Dry Products Perfect Combustion	Per Cent. Weight Dry Products—Varying Amounts Excess Air				
		20 Per Cent.	40 Per Cent.	60 Per Cent	80 Per Cent.	100 Per Cent.
CO_2	22.235	18.496	15.836	13.844	12.297	11.061
O_2	0.000	3.894	6.662	8.737	10.345	11.634
N_2	77.765	77.610	77.502	77.419	77.358	77.305
	100.000	100.000	100.000	100.000	100.000	100.000

Converting these percentages by weight of the dry products of combustion into terms of percentage by volume, the values of Table X become as in Table XI.

TABLE XI. PER CENT VOLUME DRY PRODUCTS OF COMBUSTION OF OIL

	Per Cent. Volume Dry Products Perfect Combustion	Per Cent Volume Dry Products—Varying Amounts Excess Air				
		20 Per Cent.	40 Per Cent.	60 Per Cent.	80 Per Cent.	100 Per Cent.
CO_2	15.395	12.686	10.788	9.384	8.304	7.446
O_2	0.000	3.672	6.240	8.144	9.605	10.769
N_2	84.605	83.642	82.972	82.472	82.091	81.785
	100.000	100.000	100.000	100.000	100.000	100.000

Assume, for the purpose of comparing the data thus computed with the results obtained from the use of the combustion formulas, that the oil is burned with 20 per cent. excess air and that the flue-gas analysis shows 12.686 per cent. CO_2, 3.672 per cent. O_2 and 82.972 per cent. N_2.

The weight of dry products of combustion per pound of carbon is, from formula 27,

$$\frac{11 \times 12.686 + 8 \times 3.672 + 7 \times 83.642}{3 \times 12.686} = 19.823\ lb.$$

Multiplying this value by the weight of carbon per pound of oil, we have as the weight of dry gas per pound of oil,

$$19.823 \times 0.84 = 16.651\ lb.$$

as against the value from Table VIII,

$$17.838 - 1.143 = 16.695\ lb.$$

If the carbon weight is corrected for the sulphur equivalent, the two volumes may be made to check exactly, and we have as the weight of dry gas per pound of oil

$$19.823 \times [0.84 + (0.004 \div 1.833)] = 16.695\ lb.$$

The total gas weight per pound of oil will be the dry gas weight plus the weight of moisture resulting from the burning of 0.127 lb. of hydrogen, or

$$16.695 + (0.127 \times 9) = 17.838\ lb.,$$

and since all the fuel will appear in the products of combustion, the weight of air supplied per pound of oil will be

$$17.838 - 1 = 16.838\ lb.$$

This value checks with the computed value of the theoretical requirement plus 20 per cent. excess, or

$$14.041 + (0.20 \times 14.041) = 16.837\ lb.$$

The weight of air supplied per pound of carbon from formula (28) is

$$(3.036 \times 83.64) \div 12.686 = 20.017\ lb.$$

and the weight per pound of oil, using the corrected carbon weight,

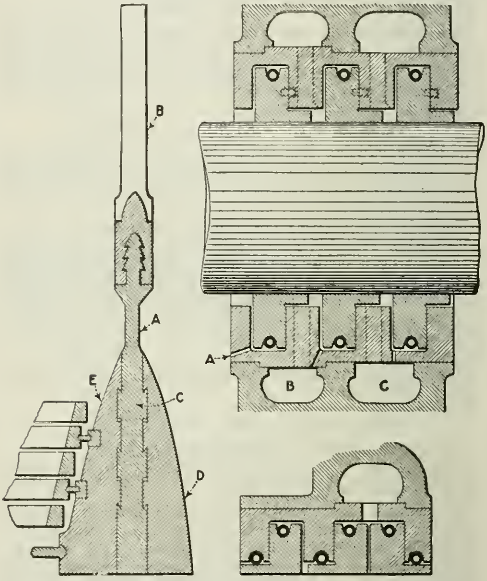
$$20.017 \times (0.84 + (0.004 \div 2.667)) = 16.843\ lb.,$$

the slight difference between this value and the actual weight being due to the nitrogen content of the oil.

New Turbine Disk and Carbon Packing Rings

Two interesting English patents relative to steam-turbine parts have been recently announced by London *Engineering*. One relates to a turbine disk for large machines and is of special interest to builders and users of turbines; this patent is by the Brush Electrical Engineering Co., London.

In the manufacture of large turbine disks for high-speed steam or gas turbines, difficulties arise in hardening the disks in order to obtain the same strength in the inner and outer parts thereof. It has therefore been proposed to build up turbine disks of a number of separate interconnected elements to relieve the strains and tensions due to rapid rotation, and the present invention relates to a turbine disk of this kind in which three members—a complete intermediate disk and two complete side disks—are connected together by means of a number of grooves having a dovetailed form, provided in the surface of the disks, and fitting one another when the side disks are shrunk on to the intermediate disk. In such an arrangement the side disks and the intermediate disks will act conjointly to resist the stresses caused by rotation. In manufacturing large turbine disks this arrangement also allows of obtaining such dimensions as may be suitable for forging and hardening. The illustration shows a longitudinal section through a turbine disk. On the intermediate member *A* of the turbine disk the radial blades *B* are arranged. By means of the dovetailed grooves *C* the outer members or the side disks *D* and *E* have been shrunk onto the intermediate disk *A*, thus forming, together with the latter, a rigid construction, so that tensions caused in the intermediate disk *A*, owing to rotation, will be transmitted to the side disks *D* and *E* and resisted thereby.



LEFT—LAMINATED TURBINE WHEEL. RIGHT—NEW FORM OF GLAND PACKING FOR TURBINES

The patent on the carbon gland rings is by the Hon. Sir C. A. Parsons, S. S. Cook and L. M. Douglas, Heaton Works, Newcastle-on-Tyne.

Carbon glands for packing steam-turbine spindles as heretofore designed consist of rings, each ring being made up of sectors of graphitic carbon or similar material, usually of rectangular cross-section, embracing the rotating shaft and held together by a spring encircling them, the purpose of such carbon gland ring being to baffle the flow of steam from a higher pressure on one side of it to a lower pressure on the other. The outer periphery of the gland ring is in such case subjected over its whole area to the higher pressure, while its inner periphery, which is in contact with or is bored to fit the surface of the shaft, is subject to a lower average pressure, owing to the fall of pressure from the high-pressure side to the low-pressure side. It follows, therefore, that there is a radial inward force on the ring pressing it toward the shaft, thus giving rise to friction-absorbing power and producing a corresponding amount of heat. In the new form of gland ring the cross-section is more or less L-shaped, and the outer circumference of the foot of the L is subjected to a lower steam pressure than that on the greatest diameter of the ring. Thus the sum of the pressures on these two faces can be made to approximate to that on the inner face, and the ring be put in equilibrium. In the drawing the high-pressure side of the packing is on the left. High-pressure steam finds its way through the opening A and bears on the outside of the first ring. Lower pressure steam is provided to the space B and acts on the smaller diameter of the first ring, besides the larger diameter of the second ring. The same arrangement is carried out with the second space C and the final low-pressure is admitted direct to the foot of the L in the case of the last ring. Several variations of the idea are mentioned in the specification.

N. A. S. E. Convention at Huntington, W. Va.

At the present writing there is every indication that the thirty-seventh annual convention of the National Association of Stationary Engineers to be held in Huntington, W. Va., during the week of Sept. 8, will be up to the usual standard of the organization. Headquarters will be at the Frederick Hotel, and the mechanical exposition will be held in the Chamber of Commerce Building. Continuing the policy inaugurated two years ago, more time will be given to technical papers and welfare discussions and less to routine business, by limiting committee and official reports to brief summaries. Five papers and two welfare discussions are on the program.

That Huntington and the surrounding territory is a new field for the convention has interested the manufacturer of power-plant products. The numerous coal mines of the state are also taking notice, and the predictions are that the exhibits will be more numerous and better than they have been for several years. The Chamber of Commerce is taking an active interest and is assisting materially the local convention committee, composed of the following seven members: C. L. Humphries, chairman; James Fields, secretary; R. C. Flaugher, R. D. Wylie, A. R. Hetzer, C. Speer and W. P. Yates. The convention program follows:

Monday, Sept. 8, official registration of delegates and visitors at headquarters, the Frederick Hotel, from 9 a.m. to 9 p.m. During the day the local reception committee will meet all trains and escort delegates and visitors to headquarters. At 8 p.m. the mechanical exposition in the Chamber of Commerce Building will be formally opened. There will be addresses by Charles Cullen, president of the National Exhibitors' Association, and Roderick Mackay, national president of the association. At 10 p.m. an informal reception of national officers will be held at the Frederick Hotel. Delegates, visitors and committeemen are expected to be present.

Tuesday, Sept. 9, at 9 a.m., officers, delegates and visitors will assemble at headquarters and parade to the Municipal Building, where the opening exercises of the convention will be held, beginning at 10 o'clock. Addresses will be made by Governor John J. Cornwell, National President Roderick Mackay, Mayor C. W. Campbell, National Vice President John J. Calahan, a representative of the Chamber of Commerce, Past National President John A. Wickert, Charles Cullen, president of the National Exhibitors' Association, and a representative of the local manufacturers' association. At the end of the opening exercises National President Mackay will announce the convention committees. The official convention photograph will be taken at noon. At 1:30 p.m. the first business session of the convention will be devoted to reports of the national officers and standing committees presented in abstract; at 3 p.m. a lecture on "National Water Power Conservation," by Thomas J. Royer, of Los Angeles, Calif.; at 4:30 p.m. the annual meeting of the Life and Accident Department will be held.

Wednesday, Sept. 10, 9 a.m., convention session for presentation of additional committee reports and routine business; 10:30 a.m., a lecture on "Bonuses in the Power Plant," by Walter N. Polakov, of New York City; 11:30 a.m., welfare discussion on "Shortening the Distance from Engine Room to Office," a general discussion for the delegates. The afternoon session will be devoted to an outing and field sports.

Thursday, Sept. 11, 9 a.m., convention session, reports

INTERIOR VIEW OF MUNICIPAL AUDITORIUM, HUNTINGTON, W. VA.

of convention committees and legislative actions on recommendations; 10:30 a.m., lecture on "Power Plant Records," by John B. McGowan, of Brooklyn, New York; 1:30 p.m., session of convention, consideration of committee reports and legislation thereon; 3 p.m., lecture on "The Consulting Engineer in the Power Plant," by Charles A. Cahill, of Milwaukee, Wis.; 4:15 p.m., welfare discussion on "Attention to Details of Operating Routine in Power Plants," a general discussion for delegates; 8 p.m., entertainment by the National Exhibitors' Association in the exhibition hall.

Friday, Sept. 12, 9 a.m., lecture on "James Watt and His Achievements," by Royal H. Holbrook, of Cedar Rapids, Iowa; 9:45 a.m., business session of the convention, legislative action on unfinished business, selection of 1920 convention city and election of officers; 8 p.m., public installation of officers and grand ball at Frederick Hotel.

Comparative Coal Production and Shipments

A report has been issued by the Geological Survey of the Department of the Interior in which the present production and shipments of coal and coke are compared with those of the corresponding period of 1918. It is shown that not only are the fields of Pennsylvania producing at a rate far below that of last year, but the same condition exists in practically every other producing district in the country.

The production of bituminous coal in the week ended July 12 is estimated at 10,169,000 net tons, an average per day of 1,695,000 tons, compared with an average of 1,492,000 tons for the five working days in the previous week, and compared with 2,214,000 tons in the week ended July 13, 1918. The production for the calendar year to date was 230,522,000 tons, or approximately 77,600,000 tons less than in the corresponding period last year. The average daily production, considering only working days, has been about 500,000 tons less this year than last year.

The estimated production of anthracite in the week ended July 12 was 1,874,000 net tons, compared with 2,136,000 tons in the corresponding week last year, and the average daily production in the week ended July 12 was 312,000 tons, compared with 282,000 tons in the previous week, and 356,000 tons in the corresponding week last year. The production of anthracite to date is estimated at 42,078,000 tons, or 10,780,000 tons less than in the corresponding period last year.

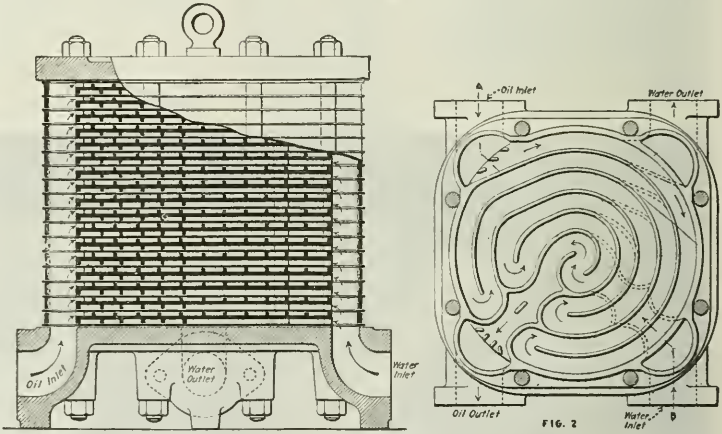
Returns from the operators for the week ended July 5 record an improvement in market conditions, the loss of time on account of no market averaging 24.3 per cent. of full time in the week, compared with 27.5 per cent. in the week ended June 28, and more than 32 per cent. in the first half of June. Market conditions in Illinois and Indiana were better, and the Hazard, Kentucky and Westmoreland, Pennsylvania, districts recorded notable improvements. Less than 4 per cent. of the full-time operation was lost because of no market in western Pennsylvania, less than 1 per cent. in the Westmoreland and neighboring fields, and central Pennsylvania showed an improvement. Car supply was better in the week ended July 5 than in the previous week in all districts except Illinois, Indiana, southern Ohio and central Pennsylvania, while losses due to shortage of labor increased in every district save southern Ohio and Alabama.

The production of beehive coke in the week ended July 12 is estimated at 325,648 net tons, compared with 680,000 tons in the week ended July 13, 1918, and with 264,328 tons in the 5-day week of July 5, 1919. The production of beehive coke to date is estimated at 10,197,481 net tons, as against 16,412,818 tons in the corresponding period of last year.

Bituminous coal dumped at lower Lake Erie ports in the week ended July 5 was 923,939 net tons, compared with 994,901 tons in the week ended June 28, and 861,093 tons in the first week of July, 1918. The total lake coal dumped from Jan. 1 to July 5, 1919, was 10,053,441 tons, compared with 8,560,516 tons in the corresponding period, last year.

The Dex Oil Cooler

In view of the developments that are taking place and the continued increase in the size of prime movers, the problem of efficiently cooling the large quantities of oil required for the bearings of turbines, thrust bearings and gear boxes—like many of the details in a large power installation—plays an important part in the smooth running of the station, and has compelled designers and those responsible for the running and maintenance of such installations to investigate the subject in some detail.



SECTIONAL ELEVATION THROUGH A-B
FIG. 1

FIGS. 1 AND 2. TWO VIEWS OF THE DEX OIL COOLER

We have received particulars of the "Dex" oil cooler (Harrison's patent), which is being manufactured by W. H. De Ritter & Co., Ltd., of Limehouse, London, E. This cooler is of a new type and, being compact and very accessible for cleaning, has advantages over many of the older patterns of tubular coolers. Its leading features are shown in Figs. 1 and 2; they consist in the use of flat plates cast with ribs (see Fig. 3) on both sides, assembled alternatively with plain rolled plates, the nest of plates being held together by bolts connecting heavy cast-iron headers on which are arranged the inlet and outlet connections for the oil and the cooling water. The ribbed plates are die-cast and then ground on both faces. This work must be carefully carried out to insure that when they are assembled with the plain plates the joints are sound. This is essential, not only to avoid short paths for the fluids, but to prevent leakage from the oil passage to the water passage, or vice versa. When it is desirable to clean or examine the plates, it is only necessary to withdraw the bolts, when each plate can be readily removed and brushed over.

The oil and water are circulated through the rectangular passages and in reverse direction in the alternate layers and after circulation are delivered to their respective pockets, as indicated by the arrows in Figs. 1 and 2.

In Fig. 2 all the oil and water passages are in parallel, but it will be readily seen that by the introduction of baffles in the pockets the parallel system of working may be changed to the series system with two, three or more flows, thus increasing the path to be traversed by the oil to be cooled.

The shallow rectangular passages for the fluids give a high heat-transmission efficiency without undue friction, and from tests carried out by the manufacturers it was found that a transmission factor of 270 B.t.u. per 1 deg. F. per square foot was obtained for a drop of 15 lb. pressure between the inlet and outlet connections. It appeared, moreover, that this transmission factor varied in direct proportion to the velocity of the oil and that the velocity was nearly proportional to the pressure.

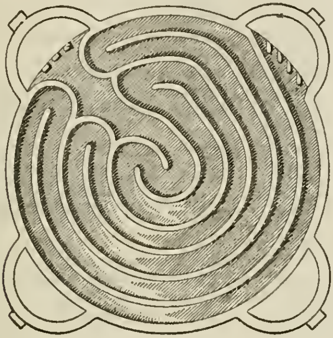


FIG. 3. FLAT PLATE, SHOWING CAST RIBS

The makers of this cooler are prepared to supply them for the services already mentioned, and also for cases where it is required to transmit heat between two substances one of which is a gas or vapor.—London *Engineering*.

Frederick Sargent

Frederick Sargent, senior member of the firm of Sargent & Lundy, of Chicago, and one of the most prominent consulting engineers in the United States specializing in the design of electric generating stations, died at his home, in Glencoe, Ill., July 26, having been taken ill while abroad. An Englishman by birth, Mr. Sargent had made numerous trips to his native country, the last of which was made in April and May of this year in company with his close friend, Samuel Insull.

Frederick Sargent was born in Liskeard, Cornwall, England, on Nov. 11, 1859, which is also the exact date of the birth of Samuel Insull, another Englishman and Chicagoan, with whom Mr. Sargent was destined to be intimately associated during practically all of his engineering activities. His people were of the farming class, but young Sargent developed a decided mechanical bent, and eight years of his boyhood and youth were spent in acquiring practical mechanical knowledge and experience in the works of John Elder & Co., the great shipbuilders on the River Clyde, near Glasgow. During this time he gained an extensive and practical knowledge of mechanical engineering, paying particular attention to heavy machinery. He also improved his education by going to night school at Glasgow University. Coming to the United States about 1880, he found employment in Eastern shipbuilding yards as a designer of steam engines. He then went West as a designer for the Sioux City (Iowa) Engine Co. A year or so later he accepted a position with E. P. Allis & Co., of Milwaukee, predecessors of the present Allis-Chalmers Manufacturing Co. Here he attracted the attention of the officers of the Western Edison Light Co., organized in Chicago in 1882 to exploit the electric-lighting inventions of Thomas A. Edison in the West, and in the fall of 1884 he moved to Chicago and began his career as an electrical engineer in that city.

Succeeding the Western Edison Light Co., the Chicago Edison Co. was formed in 1887. This was the first distinctively Edison central-station company in Chicago. Mr Sargent became its consulting engineer, and he has been consulting engineer of that company and its successor, the present Commonwealth Edison Co., ever since.

About 1889 he went to New York under contract with the Edison United Manufacturing Co. In this position he had general charge of all the work done by that company in the United States and Canada. Shortly after this the company in New York was reorganized as the Edison General Electric Co. Mr. Sargent was made assistant chief engineer of the new corporation, of which Samuel Insull was vice president in charge of manufacturing. But Mr. Sargent had determined to open an office of his own, and, in August, 1890, he returned to Chicago and established himself as an independent electrical and mechanical engineer. The firm of Sargent & Lundy was formed in 1891.

In 1891 and 1892 Mr. Sargent was consulting electrical engineer for the World's Columbian Exposition, and he designed the power plant and had much to do with the other mechanical and electrical features of the great World's Fair of 1893.

The original Edison central station in Chicago was built about 1889. Mr. Sargent made the plans for the machinery layout of that station. In 1892 Samuel Insull came to Chicago as president of the Chicago Edison Co., and that company at once took on a new lease of life. Under Mr. Insull's direction the old Harrison Street station, recently torn down to make way for the Union Station railroad improvements, was built. Mr. Sargent was the designer of that station, also the Fisk Street Station, the Quarry Street Station and the Northwest generating stations of the Commonwealth Edison Company.

FREDERICK SARGENT

He was one of the first mechanical engineers who recognized the great part that the steam turbine was destined to play in the development of electric generating stations. The Fisk Street Station was the pioneer of all the large turbine central stations of the world, and it became deservedly famous for its many original features of design and for the simplicity and economy of operation. After this station had been in operation for a short time, Mr. Sargent was sent to London as a representative of the United States on the hearing in Parliament in connection with the London power-supply bill. This hearing crystalized in Mr. Sargent's mind some ideas he had been developing about the importance of unified power supply for great industrial centers so as to reduce the cost of production, and on his return he submitted his ideas to Mr. Insull, and they were marked out in the power station development of the Commonwealth Edison Company.

Mr. Sargent's engineering work was not confined to Chicago. He was consulting engineer for many of the important electric-light and power companies throughout the country, including the Edison Electric Illuminating Co., Boston; American Gas and Electric Co., New York; Electric Bond and Share Co., New York; the Union Gas and Electric Co., Cincinnati, and many other smaller organizations.

He designed the great combined central power station of the American Gas and Electric Co. and the West Penn Power Co., located on the Ohio River, north of Wheeling, W. Va., which is the first large electric station to be built in a favorable locality on a coal mine for the distribution of power to industrial centers at long distances.

He designed the great new station of the Union Gas and Electric Co., at Cincinnati, which was recently completed. He also designed the new station for the Kansas City Light and Power Co., which is soon to be put into operation. He went to Chile in 1916 as consulting engineer for the Guggenheim mining interests on the development of a power supply for their mine at Chuquicamata.

During the war Mr. Sargent was consulting engineer for the power station of the Edgewood Arsenal, at Edgewood, Md., and also consulting engineer for the United States Government in other wartime projects demanding the application of power on a large scale.

In his profession Mr. Sargent was noteworthy for the clear vision and strong common sense with which he grappled with the essentials of an engineering problem. He was simple, clear, direct and practical. He was a man of broad outlook, tolerant, modest, seeking to achieve results rather than to uphold theories. And he was eminently successful in obtaining results, for his electrical generating stations were milestones of achievement in the economical production of electrical energy.

Mr. Sargent was awarded a medal by the World's Columbian Exposition in 1893. He was a member of the jury of awards in power engineering at the St. Louis Exposition of 1904. He was a member of several societies and clubs, including the American Society of Mechanical Engineers, Western Society of Engineers, University Club, Chicago Yacht Club, Skokie Country Club and the Engineers Club, New York.

He is survived by a widow, one daughter and two sons.

New N. A. S. E. in New Brunswick, N. J.

State Deputy John J. Reddy of New Jersey continues to institute new subordinate associations in his state. Tuesday evening, July 29, he instituted an association at New Brunswick, about twenty engineers joining. Wurt Illig was elected president. Among those present were: National Vice President John J. Calahan, William Reynolds, chairman of the board of trustees; Howard Cole, of New York; James S. Heath, past president of the New Jersey State Association, and Charles H. Bromley, of the State Educational committee.

During the two years Mr. Reddy has been deputy, he has instituted associations at Phillipsburg, Dover, Cape May, New Brunswick and Camden, the last having been instituted Aug. 1. Such excellent results are due to the combined efforts of Mr. Reddy and the visiting committee centered around the unusually hard work of the educational committee.

Personals

E. O. Floyd has been appointed general sales manager of the Rosendale-Reddaway Belting and Hose Co., Newark, N. J.

N. S., Thulin has been appointed special railroad representative on the staff of S. C. Sprague, manager of Western railroad sales for the Chicago Pneumatic Tool Co.

Herman G. Hardy, formerly connected with the Old Hickory Powder Plant at Jacksonville, Tenn., is now chief mechanical and electrical engineer of the Arizona Copper Co., Ltd., Clifton, Ariz.

Capt. H. P. Childs, of the 23rd Engineers, recently returned from France, is now representing the Frederick Iron and Steel Co., of Frederick, Md., manufacturers of centrifugal pumps and other engineering products, at 61 Broadway, New York City. Prior to his military service Mr. Childs was assistant to the first vice president and general manager of the Westinghouse Machine Co. in New York.

George H. Diman, formerly with the American Woolen Co.'s mills, Lawrence, Mass., has retired from active duty with this company after 32 years of continuous service. He is still retained as a member of the company's general advisory board. Of his 74 years, 53 have been spent as a power-plant engineer in the textile mills of New England. He has specialized as a fuel economist and in the economical use of steam for power production and manufacturing purposes. His arrangement with the American Woolen Co. does not preclude his consultation by others, and he is available for such service, consulting and otherwise, as his long and extended experience has fitted him to render.

Miscellaneous News

The Alberta Industrial Development Association will hold an Industrial Congress and Provincial Tour, Aug. 11-17. The congress will be held at Calgary, Aug. 13-14, and the tour, by special train, begins at Medicine Hat on Aug. 11, concluding at Banff in the Canadian Rockies, on Aug. 17. The congress will place before its visitors data in relation to the natural resources and industries of Alberta and the Canadian West with the object that more serious consideration be given to the economic development of trade relations between the United States and Canada. Many men of international reputation will address the convention.

Business Items

J. C. Bennett, of Detroit, is now manufacturing Planet soot blowers for all types of boilers at Windsor, Ont., Can., under the name of J. C. Bennett & Co. The Equipment Specialties Co., Ltd., of Montreal and Toronto, have been given the exclusive sales rights, as has also the Marion Machine and Foundry Supply Co., of Marion, Ind.

The Sullivan Machinery Co., Chicago, Ill., announces the following changes in its personnel: Marion C. Mitchell has been appointed sales manager for the territory in Indiana and Illinois, previously controlled from the St. Louis office, with temporary headquarters in the Railway Exchange, St. Louis; Don M. Sutor, formerly manager of the El Paso office, has been appointed sales manager for the territory of western Kentucky, western Tennessee, Missouri, Arkansas, Oklahoma and Kansas (except the oil territory), with headquarters at Railway Exchange, St. Louis; Daniel H. Hunter has been appointed sales manager for Louisiana, Texas (except the southwestern section), and the oil fields of Oklahoma and Kansas, with headquarters in Dallas, Tex.

Trade Catalogs

Jos. H. Roach & Co., Inc., Philadelphia, Penn., has issued a 15-page catalog fully illustrating and describing "The Roach Stoker."

Hornung Pressure and Temperature Control. J. C. Hornung, Chicago, Ill. Bulletin No. 14. Pages 12; 6 x 9 in.; fully illustrated

United Stokers Corp., Chicago, Ill., has issued an 8-page Bulletin No. 100, illustrating and describing the "Simplex Steam Jet Ash Conveyor." A copy of this bulletin may be had free upon request.

The Spray Engineering Co., Boston, Mass., has issued a 16-page bulletin illustrating and describing the "Spraco Air Washing and Cooling Equipment," which is especially applicable to Steam Turbine Generators.

The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Penn., has just issued its 23-page Application Circular 7375, on "Electrical Precipitation," describing the recovery of valuable material from smoke and gases; fully illustrated.

The Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has issued a 17-page bulletin No. 1538 on "Forgings." Illustrations showing some of the company's forge and machine-shop equipment used in the production of forgings are given.

The Black & Decker Manufacturing Co., Baltimore, Md., has recently issued a catalog giving a full and illustrated description of electric air compressors, portable electric drills, and electric valve grinders. A copy of this catalog may be had free upon request.

The Vulcan Soot Cleaner Co., Du Bois, Penn., has issued bulletin No. 541, which illustrates in two colors and describes the Vulcan patented diagonal method for cleaning soot from the tubes of horizontal water-tube boilers. A copy of the bulletin may be had free upon request.

The Wellman-Seaver-Morgan Co., Cleveland, Ohio, has issued Bulletin No. 22, containing three full-page charts giving the relations in any shaft between power, shaft diameter, torsional stress and speed, with examples showing methods of use of charts. This useful bulletin for engineers and draftsmen may be had free upon request.

The Texas Co., New York City, has just published a 46-page book, 9¼ x 12¼ in., entitled "Texaco at Home and Abroad." The book is very nicely printed and prettily illustrated with pen and pencil sketches of interesting items and short stories about the business, which reveal more than a little of the interest and even of the romance that permeates the operation of so large and successful a business as the marketing of Texaco petroleum products throughout the world.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7 80@7 95
Stove	7.95@8 15
Chestnut	8.05@8 35

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2 35@2 80	$2 80@3.60
Philadelphia, gross tons	4 49@5.00	5.00@5.80
New York, gross tons	4 85@5 35	5 35@6 15
Alongside Boston (water coal), gross tons	6.35@7.05	6 85@7 65

Pocahontas and New River are quoted at $6.00 @6.25 per gross ton f.o.b. Norfolk and Newport News, Va., in response to export demand. There are practically no spot sales for coastwise shipments.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5.95	$7 80	Pea	5.20	6.95
Egg	6 25	8.10	Buckwheat	3 40	5 15
Stove	6.50	8.35	Rice	2 75	4 50
Chestnut	6 60	8.45	Barley	2 25	4 00

Bituminous

	Spot
South Fork (Best)	$2 95@3 25
Cambria (Best)	2 95@3 10
Cambria (Ordinary)	2 45@2 60
Clearfield (Best)	2 95@3 10
Clearfield (Ordinary)	2 45@2.60
Reynoldsville	2 50@2 75
Quemahoning	2 85@3 00
Somerset (Best)	2.85@3 00
Somerset (Poor)	2 35@2 60
Western Maryland	2 35@2 60
Fairmont	1.90@2 25
Latrobe	2 20@2.35
Greensburg	2.35@2 50
Westmoreland ¾ in	2 75@2 90
Westmoreland run-of-mine	2.50@2.60

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide	Anthracite	Line	Tide
Broken	$5.95	$7 80	Buckwheat	$3.40	$4 45
Egg	6.05	7 90	Rice	2.75	3 65
Stove	6.30	8 15	Boiler	2.50	3 50
Nut	6 40	8 25	Barley	2.25	3.15
Pea	5 00	6 60	Culm	1.25	2.15

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2 75	$3 25
Mine-run	2 35@ 2 50	3.00
Screenings	1 40@ 1 60	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2 45	$2 75	$2 40
Black Creek and Cahaba	3.45	3 75	3 05
Jagger - Pratt Corona	2 85	3.05	2 45
Blacksmith		5 25	

Domestic quoations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3 95@$4 60
Corona	3 50
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

Franklin County		Mt. Olive and Staunton	Standard
Prepared sizes, lump, egg, Nos. 1 and 2 nut	$2 75		
Williamson County			
Prepared sizes, lump, egg, nut	$2 55	$2 55	$2 00@2 25
Mine-run	2.35	2 20	1.60@1.75
Screenings	2 20	2.05	1.15@1.30
3-in. lump		2 30	
2-in. lump			1.75@1.90

Williamson-Franklin rate to St Louis is $1 07: other rates 92½c.

Engr.

New Construction

PROPOSED WORK

Mass., Worcester—The Worcester Paper Box Co., 68 High St., will soon receive bids for the construction of a 2 story, 60 x 150 ft. garage on Austin St. and Houchin Ave. A steam heating system will be installed in same. Total estimated cost, $45,000. S. H. Pitcher Co., 44 Front St., Engr.

Conn., Stamford—The Board of Education plans to construct a grammar school on State and South St. A steam heating system will be installed in same. Total estimated cost, $225,000. Emmens & Abbott, Washington Bldg., Engr.

N. Y., Brooklyn—Coyne & Delaney, 832 Kent Ave., will install a steam heating system in the 3 story, 50 x 120 ft. factory which it plans to build on Flushing and Mount Olivet Ave. Work will be done by day labor. Total estimated cost, $70,000.

N. Y., Brooklyn—The New York Congregational Home for the Aged, 123 Linden Ave., will install a steam heating system in the 3 story, 38 x 65 ft. hospital addition which it plans to build. Total estimated cost, $65,000. Parfit Bros., 26 Court St., Engr.

N. Y., Brooklyn—The State Hospital Commission, Capitol, Albany, received bids for the installation of a new engine and generator at the Brooklyn State Hospital, here. from T. F. Jackson, 99 John St., New York City, $9,187; G. E. Engineering Co., Laith & Varrick St., New York City, $9.750; Jandous Electric Equipment Co., 109 West 31st St., New York City, $9.770.

N. Y., Falconer—The Merriam Cabinet Co. plans to remodel the Chatauqua Planing Mills and install electric power units. Total estimated cost, $60,000.

N. Y., Flushing—The Board of Education, 500 Park Ave., New York City, will install a steam heating system in the 3 story school which it plans to build on Jamaica Road. Total estimated cost, $300,000. C. B. J. Snyder, Municipal Bldg., New York City, Engr.

N. Y., Little Falls—The Barnet Leather Co., 598 East Mill St., plans to build a 3 story addition to its plant. Power units will be installed in same. Total estimated cost, $65,000. E. L. White, Supt.

N. Y., New York—The Cudahy Packing Co., 454 West 14th St., will receive bids about August 8 for the construction of a 2 story addition to its packing house at 611 West 34th St. A steam heating system will be installed in same. Total estimated cost, $50,000.

N. Y., New York—St. Mary's Free Hospital, 407 West 34th St., will receive bids until August 1 for the construction of a 5 story, 40 x 50 x 100 ft. Nurses' Home. A steam heating system will be installed in same. Total estimated cost, $75,000. C. P H. Gilbert, 1123 Broadway, Engr.

N. Y., Syracuse—The Board of Education of Onondaga Valley plans to construct a 2 story, 150 x 200 ft. school here. Separate bids are desired for installing heating system and fan system of ventlating. Total estimated cost, $350,000. Ford, Buck & Sheldon, 60 Prospect St., Hartford, Conn., Engr.

N. Y., Watertown—The Northern New York Utilities, Inc., Light & Power Bldg., is having surveys made and plans prepared for the construction of a steel tower high tension transmission line from here to the Black River. H. G. Davis, Ch. Engr.

N. J., Bayonne—The Board of Education will receive bids until September 4, for the construction of a 4 story brick school on Avenue C. A steam heating system will be installed in same. Total estimated cost, $200,000. Donald Anderson, Bayonne, Arch.

N. J., Trenton—The Thermoid Rubber Co., Whitehead Rd., will install a steam heating system in the 3 story, 100 x 270 ft. plant which it plans to build. Total estimated cost, $150,000. Osborn Engineering Co., 2848 Prospect Ave., Cleveland, Ohio, Engr.

Pa., Duryea—The Universal Industrial Corporation plans to build a 1 story, 52 x 130 ft. silk mill with a 30 x 40 ft. wing. A steam heating system will be installed in same. E. H. Davis and G. M. D. Lewis, Union Bank Bldg., Scranton, Arch.

Pa., Oliphant—The Scranton Gas & Water Co. will install a steam heating system in the 1 story, 25 x 50 ft. office building which it plans to build. E. Davis and A. M. Lewis, Union Trust Bldg., Scranton, Arch.

Pa., Plymouth—The Congregation of St. Leo's Polish Catholic Church will install a steam heating system, including capital boilers in the 2 story, 50 x 133 ft. church which it plans to build. Total estimated cost, $90,000. Moms & McKale, Burr Bldg., Scranton, Arch.

Pa., Scranton—The Maccar Truck Co. will build a 1 story, 45 x 70 ft. power plant on Mulberry Ave. Total estimated cost, $60,000. Dans & Lewis, Union Bank Bldg., Arch.

S. C., Lake City—The city will receive bids about August 20 for the construction of a waterworks system, including steel tank and tower, deep well pumping machinery, boiler, etc. Total estimated cost, $90,000. Tomlinson Engineering Co., 1003 Loan & Exchange Bank Bldg., Columbia, Engr.

Ga., Columbus—The Bibb Manufacturing Co. plans to construct a transformer house in connection with the cotton weave shed which it plans to build. Robert & Co., Chandler Bldg., Atlanta, Engr.

Ohio, Ashland—The Ashland Tire & Rubber Co. will install a steam heating system in the 2 story, 75 x 125 ft. plant which it plans to build here. Total estimated cost, $90,000. Osborn Engineering Co., 2848 Prospect Ave., Cleveland, Engr.

Ohio, Ashland—The Faultless Rubber Co will install a steam heating system in the 3 story, 80 x 160 ft. factory addition which it plans to build. Osborn Engineering Co. 2848 Prospect Ave., Cleveland, Engr. Total estimated cost, $75,000.

Ohio, Cleveland—The Chandler Motor Car Co., East 131st St. and St. Clair Ave. will install a steam heating system in the 3 story, 80 x 400 ft. machine shop addition which it plans to build. Total estimated cost, $200,000.

Ohio, Cleveland—The Hellanic Orthodox Community, West 14th St., will install a steam heating system in the 2 story, 46 x 85 ft. church which it plans to build at 2167 West 14th St. Total estimated cost, $75,000.

Ohio, Cleveland—The Jordon Motor Car Co., 1057 East 152nd St., will install a steam heating system in the 2 story, 97 x 167 ft. factory addition which it plans to build. Total estimated cost, $75,000.

Ohio, Cleveland—The Joseph Laronge Co., 214 Williamson Bldg., will install a steam heating system in the 12 story, 225 x 230 ft. theatre and office which it plans to build on East 17th St. and Euclid Ave. Total estimated cost, $2,500,000.

Ohio, Cleveland—Benjamin Moore & Co., 1314 Marquette Ave., plans to build a 4 story, 60 x 100 ft. factory on East 71st St. and Grant Ave. A steam heating system will be installed in same. Total estimated cost, $60,000. Architect not selected.

Ohio, Cleveland—Sommer Adams Co., 2934 East 55th St., plans to build a 2 story, 60 x 100 ft. power house and factory and will install a steam heating system in same. Estimated cost, $75,000.

Ind., Whiting—The Owl Club will install a steam heating system in the 5 story, 45 x 65 ft. club building which it plans to build. Total estimated cost, $65,000. Zimmerman, Saxe & Zimmerman, 64 East Van Buren St., Chicago, Arch.

Mich., Detroit—The Board of Education received bids for installing a heating and ventilating system in the 2 story addition to the A. L. Holmes School, Georgia and Crane Ave., from Ernst Bros. Co., 35 Bagg St., $57,040. John O'Connor, Penobscot Bldg., $57.988; James W. Partlan, 51 Park Pl., $59,400.

Mich., Detroit—The Fruehauf Trailer Co., 1371 Gratiot Ave., will install a steam heating system and electric motors to supply power in the 2 story, 100 x 260 ft. factory which it plans to build along the tracks of the Detroit Terminal R. R. near Deyninder St. Total estimated cost, $100,000. Stahl & Kinsey, McKerchey Bldg., Arch

Ill., Chicago—The Century Rubber Works, 1346 Rawson St., will install a steam heating system in the 3 story, 200 x 350 ft. factory which it plans to build on La Salle St. Total estimated cost, $200,000. Osborn Engineering Co., 2848 Prospect Ave., Cleveland, Ohio, Engr.

Ill., Chicago—Lubiner & Trinz, 25 East Jackson Blvd., will install a steam heating system in the 2 story, 125 x 215 ft. theatre which it plans to build on Kedzie and Madison St. Total estimated cost, $500,000. W. W Ahlschlager, 111 West Washington St., Arch.

Wis., Peshtigo—The Peshtigo Pulp & Paper Co. will install a steam heating system in the 2 story, 70 x 178 ft. factory which it plans to build on Main St. Total estimated cost, $55,000. Address J. A. Kittle, Peshtigo, Pres.

Kan., Harper—The city has engaged W. B. Rollins & Co., Engr., 209 Railway Exchange, Kansas City, Mo., to prepare plans for the construction of a waterworks systm, including pumping equipment, engine, generator and pipe lines. Total estimated cost, $35,000.

Kan., Hudson—The city is having plans prepared by W. B. Rollins & Co., Engr., 209 Railway Exchange Bldg., Kansas City, Mo., for the construction of a transmission line for electric plant. Estimated cost, $15,000.

Kan., Hutchinson—R. E. Johnson will install a steam heating system in the 1 story theatre, which he plans to build here. Total estimated cost, $100,000. W. E. Hulse & Co., Hutchinson, Arch.

Kan., Manhattan—The Rocky Ford Milling & Power Co. is having plans prepared for a 2 story building and will install a 7000 hp. steam engine and 3000 kw. and 2000 k.w. turbines. Total estimated cost, $500,000.

Kan., Sharon Springs—The city will soon award the contract for the construction of a brick power house and the installation of 2 motor driven pumps and 1 or 2 oil engines with generators. Black & Veatch, Interstate Bldg., Kansas City, Mo., Engr.

S. D., Sioux Falls—The Board of Education will soon award the contract for the construction of a 2 story, 65 x 130 ft. school. A steam heating system will be installed in same. Total estimated cost, $100,000. Holmes & Flinn, 8 South Dearborn St., Chicago, Ill., Arch.

N. M., Socorro—E. T. Brown, Secy. and Treas. of the New Mexico State School of Mines, will soon award the contract for installing new heating plants in the School of Mines buildings, here.

Utah, Salt Lake County—The Davis County Irrigation Co. will build a pumping plant to irrigate 5000 acres. Estimated cost, $25,000. J. T. Hatch. Pres.

Ore., Condon—The County Court of Gillian Co. will soon award the contract for the installation of a vapor heating system in the courthouse. J. E. Schroeder, City Clk.

Ore., Pendleton—The School Board of District No. 16, 111 East Court St., will soon award the contract for the installation of a furnace hot blast or steam heating system, etc., in Hawthorne School. Estimated cost, $5000. R. W. Hatch, Despain Bldg., Arch.

Cal., Palo Alto.—The Board of Public Works received bids for furnishing and installing Deisel engine at the Municipal power plant, from McIntosh-Seymour Corporation, 461 Market St., San Francisco, at $48,900; electric generating unit, from the General Electric Co., Rialto Bldg., San Francisco, at $5680.

Ont., London—The Dominion Government, Ottawa, is having plans prepared by the Department of Public Works for the construction of a 3 story post office and customs building. A steam heating system will be installed in same. Total estimated cost, $400,000.

Ont., London—C. S. Hyman Co., Ltd., will soon award the contract for the construction of a 5 story, 150 x 300 ft. tannery on St. George St. A steam heating system will be installed in same. Total estimated cost, $300,000. H. C. McBride, Molsons Bank, Arch.

Ont., London—The McClary Manufacturing Co., 333 Wellington St., will install a steam heating system in the 5 story, 72 x 125 ft. addition which it plans to build to its factory on York St. Total estimated cost, $60,000. J. M. Moore, 425 Richmond St., Arch.

Ont., Victoria—The Town Council has appointed a committee to get estimates on hydro-electric power and lighting system for Charletteville Twp.

CONTRACTS AWARDED

N. Y., Brooklyn—E. Greenfield & Son, 95 Lorimer St., has awarded the contract for the construction of a 6 story, 40 x 100 ft. factory on Lorimer St. and Marcy Ave., to the Turner Construction Co., 242 Madison Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $80,000.

N. Y., Brooklyn—The Congregation of the Zion Norwegian Lutheran Church, 6301 5th St., has awarded the contract for the construction of a 1 story, 50 x 100 ft. church on 63rd St. and 4th Ave., to T. Drysdale, 250 Baltic St. A steam heating system will be installed in same. H. L. Otto, 21 Park Row, New York City, Engr.

N. Y., Central Islip—Lewis F. Pilcher, State Arch., Capitol, Albany, has awarded the contract for installing coal and ash handling equipment at the Central Islip State Hospital to the Guarantee Construction Co., 140 Cedar St., New York City. Estimated cost, $59,350.

N. Y., Cornell (East Freetown P. O.)—The Standard Oil Co., 26 Broadway, New York City, has awarded the contract for the construction of a 2 story, 46 x 52 ft. garage and office building, to H. D. Best, 949 Broadway, New York City. A steam heating system will be installed in same.

N. Y., Long Island City—B. Bleckman, 199 Lafayette St., New York City, has awarded the contract for the construction of a 6 story, 132 x 200 ft. factory, on Nott, Manby, Anable and Mount St., to Levening & Garrigue, 552 West 23rd St., New York City. A steam heating system will be installed in same. Total estimated cost, $400,000.

N. Y., Long Island City—The Tidewater Oil Co., 11 Broadway, New York City, has awarded the contract for the construction of a 2 story, 30 x 140 ft. warehouse on Greenpoint Ave. and Newtown Creek, to H. D. Best, 949 Broadway, New York City. A steam heating system will be installed in same.

N. Y., New York—R. T. Crane, Jr., 1550 Lake Shore Drive, Chicago, has awarded the contract for the construction of a 4-story reinforced concrete warehouse at 1996-2010 Park Ave., to the White Construction Co., 95 Madison Ave. A steam heating system will be installed in same. Total estimated cost, $175,000.

N. Y., Potsdam—T. E. Finegan, Deputy Comr. of Education, Education Bldg., Albany, has awarded the general contract for the construction of a new boiler house at the Potsdam Normal School, to H. M. Weed, 200 5th Ave., New York City, $42,300, heating work, to H. J. Brandeles, 431 Lafayette St., Utica, $36,000. Noted July 22.

N. J., Jersey City—The city has let the contract for the construction of Public School No. 23 on Central Ave., to Michael T. Connelly, 238 17th St. A steam heating system will be installed in same. Total estimated cost, $643,000.

Ohio, Cleveland—The National Lamp Co., Nela Park, has awarded the contract for the construction of a 3 story, 80 x 110 ft. factory, to Sam W. Emerson Co., 1900 Euclid Ave., Cleveland. A steam heating system will be installed in same. Total estimated cost, $200,000.

Ill., Columbia—The village has awarded the contract for the construction of a light and power plant, to Baumes-McDevitt Machinery Co., Railway Exchange Bldg., St. Louis, Mo. A 100 hp. H. R. T. boiler and breeching, 100 ft. x 4 inch concrete chimney, 120 hp. non-releasing Corlis or Unaflow engine and heaters will be installed in same. Total estimated cost, $100,000.

Minn., Austin—The city has awarded the contract for installing a boiler at the municipal electrical plant, to Babcock & Wilcox Co., Chicago, $12,177, stoker, to Robinson, Carey & Sands, 4th and Wacouta St., St. Paul, $7440.

Minn., Minneapolis—The State Board of Control, Capitol, St. Paul, has awarded the contract for installing new generating units for the electric light plant, to J. W. Hildred Co., 33 East 3rd St., St. Paul, an engine at $5,980 and a refrigerating plant at $9980, to the General Electric Co., 410 3rd Ave., a generator at $3,035. Noted July 1.

Mo., St. Joseph—The St. Joseph Railway Light, Heat & Power Co., has awarded the contract for the construction of two 225 ft. stacks, one 16 ft. and the other 12 ft. in diameter, to the Kansas City Structural Steel Co., 705 Orear Leslie Bldg., Kansas City, 110 tons structural under framing, 31 tons breeching and 86 tons reinforcing, to the Structural Steel Co., Kansas City. All awarded on tonnage basis. Noted July 1.

N. M., Magdalena—The H. W. Light & Power Co. has awarded the contract for the construction of a 51 x 101 ft. light and power plant and ice plant, to Osborn & Catalano, Magdalena, $13,000.

Cal., Los Angeles—The Board of Education, Security Bldg., has awarded the contract for installing a steam heating system in the school which it plans to build on East 7th St., to Arthur Hess, Baker-Detwiler Bldg. Estimated cost, $8923.

N. B., Presque Isle—The Maine & New Brunswick Power Co. has awarded the contract for enlarging dam and power house and installing 1875 k.v.a. unit in its present plant, to the Foundation Co., Montreal, Que. Estimated cost, $125,000.

N. B., Marysville—The Nashwaak Pulp & Paper Co., Ltd., has awarded the contract for a dam and water power development, to the Ambursen Hydraulic Construction Co. of Canada, Ltd., New Birks Bldg., Montreal, Que.

"SEARCHLIGHT" Clippings:

For "Opportunities" — THINK "SEARCHLIGHT" FIRST! See pages 83 to 93

PRICES - MATERIALS - SUPPLIES

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE—

Fire	50-Ft. Lengths
Underwriters' 2½-in.	70c per ft.
Common, 2½-in.	40–10%

Air	First Grade	Second Grade	Third Grade
¾-in. per ft.	$0 45	$0 30	$0 20

Steam—Discounts from List

First grade. 35% Second grade..... 45% Third grade.... 50%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition 65% Best grade 40%

Standard 50–10%

Note—Above discounts apply on new list issued July 1.

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	45%	35%
St. Louis	45%	35%
Chicago	45%	40%
Birmingham	30%	35%
Denver	35–5%	30%

RAWHIDE LACING—20% for cut; 45c. per sq. ft. for ordinary.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0 90
Asbestos for high-pressure steam	1 50
Duck and rubber for piston packing	1.00
Flax, regular	1 20
Flax, waterproofed	1 60
Compressed asbestos sheet	90
Wire insertion asbestos sheet	1 10
Rubber sheet	50
Rubber sheet, wire insertion	70
Rubber sheet, duck insertion	50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1 20
Asbestos wick, ½- and 1-lb. balls	85

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin. Ft.	Thickness	Price per Sq. Ft.
1-in.	$0 27	½-in.	$0 27
2-in.	.36	1 -in.	.30
6-in.	80	1½-in.	45
4-in.	60	2 -in.	60
3-in.	.45	2½-in.	.75
8-in.	1 10	3 -in.	90
10-in.	1.30	3½-in.	1 05

85% magnesia high pressure		List
For low-pressure heating and return lines	4-ply	58% off
	3-ply	60% off
	2-ply	62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Pittsburgh	Chicago	St. Louis	Birmingham	Denver
Cup	7	9	5½	7	8½	14½
Fiber or sponge	8	10	6	13	8½	18
Transmission	7	9	6	13	8½	20
Axle	4½	6	4	4 75	4	5½
Gear	4½	9	4½	7 5	8½	8
Car journal	22 (gal.)	21 (gal.)	3½	4 9	8½	8

COTTON WASTE—The following prices are in cents per pound:

	New York Current	New York One Year Ago	Cleveland	Chicago
White	11 00 to 13 00	13 00	14 00	11 00 to 14 00
Colored mixed	8 50 to 12 00	12 00	11 00	9 50 to 12 00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13½ x 13½	13½ x 20½
Cleveland	$52 00	$58 00
Chicago	41 00	43 50

LINSEED OIL—These prices are per gallon:

	New York Current	New York One Year Ago	Cleveland Current	Chicago Current	Chicago One Year Ago
Raw in barrels (5 bbl. lots)	$2.15	$1.86	$2.15	$2.48	$2.53
5-gal. cans	2.28	1.96	2.40	2.68	2.73

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	13 00	14 50	14 00	14 50	13 00	14.00
25- and 50-lb. kegs	13 25	14 75	14 25	12 75	13 25	14 25
12½-lb. keg	13 50	15 00	14 0	15 00	13 50	14 50
1-lb. cans	16 00	17.50	....	....	16 00	17 00
5-lb. cans	15 00	16 50	....	....	15 00	16.00

500 lb. lots less 10% discount; 2000 lb. lots less 10-2½%

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel 7/16 and smaller	65%	60–5%	45%
Tinned	65%	60–5%	40%

Boiler rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York. $6 35 Cleveland.. $4 00 Chicago $4.87 Pittsburgh. $4 65

Structural rivets, same sizes:

New York.... $6. 25 Cleveland.. $4 10 Chicago $4 97 Pittsburgh... $4 75

REFRACTORIES—Following prices are f. o. b. works, Pittsburgh:

Chrome brick	net ton	$90–100	at Chester, Penn.
Chrome cement	net ton	45–50	at Chester, Penn.
Clay brick, 1st quality fireclay	net ton	35–45	at Clearfield, Penn.
Clay brick, 2nd quality	net ton	30–35	at Clearfield, Penn.
Magnesite, dead burned	net ton	32.50	at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80–90	at Chester, Penn.
Silica brick	net ton	41–45	at Mt. Union, Penn.

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—Fire Clay, $30 to $40.

Birmingham—Fire clay, $41–$44, silica, $46.50–$54.50; magnesite, $80-$85; chrome, $80-$90.

Chicago—Second quality, $25 per ton.

Denver—Silica, $35 per 1000.

FUEL OIL—Domestic light, 22-26 deg., Baume, is 8½c. per gal. in St. Louis

BABBITT METAL—Warehouse prices in cents per pound:

	New York Current	New York One Year Ago	Cleveland Current	Cleveland One Year Ago	Chicago Current	Chicago One Year Ago
Best grade	90 00	125.00	79 00	108 00	75.00	100 00
Commercial	50 00	70.00	17 50	23 00	15 00	24 00

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$21–26	$19 00
Cleveland	20 00	20 00
Chicago	16.50	19 00

In coils an advance of 50c. usually is charged.

Domestic iron (Swedish analysis) is selling at 15c. per lb.

POLES—Prices on Western red cedar poles:

	New York	Chicago	Denver	San Francisco
6 in. by 30 ft	$5 82	$5.17	$4 55	$5.17
7 in. by 30 ft	7 65	6 85	6.10	6 85
7 in. by 35 ft	11 10	10 00	8 95	10 00
8 in. by 35 ft	12 65	11 35	10 10	11 35
7 in. by 40 ft	12 85	11 50	10 20	11 50
8 in. by 45 ft	18.90	16 90	15 00	16 90
8 in. by 50 ft	22.65	20 30	18 00	20 30

10c. higher freight rates on account of double loads.

For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft	$9 00
12-in. butts, 6-in. tops, length 30-40 ft	11 50
12-in. butts, 6-in. tops, length 41-50 ft	12 50
14-in. butts, 6-in. tops, length 51-60 ft	21 00
14-in. butts, 6-in. tops, length 61-71 ft	23.50

PIPE—The following discounts are for carload lots f. o. b. Pittsburgh; basing card of Jan. 1, 1919, for steel pipe and for iron pipe:

Steel Inches	Steel Black	Steel Galvanized	Iron Inches	Iron Black	Iron Galvanized
BUTT WELD					
⅛, ¼, and ⅜	50½%	24%	¾ to 1½	39½%	23½%
½	54½%	40%			
¾ to 3	57½%	44%			
LAP WELD					
2	50½%	38%	2	32½%	18½%
2½ to 6	53½%	41%	2½ to 6	34½%	21½%
BUTT WELD, EXTRA STRONG PLAIN ENDS					
⅛, ¼ and ⅜	46½%	29%	¾ to 1½	39½%	24½%
½	51½%	39%			
¾ to 1½	55½%	43%			
LAP WELD, EXTRA STRONG PLAIN ENDS					
2	48%	37½%	2	33½%	20½%
2½ to 4	51%	40½%	2½ to 4	35½%	23½%
4½ to 6	50%	39½%	4½ to 6	34½%	22½%

Stock discounts in cities named are as follows:

	New York Black	New York Galvanized	Cleveland Black	Cleveland Galvanized	Chicago Black	Chicago Galvanised
½ to 3 in. steel butt welded	47%	31%	43½%	34½%	57½%	44%
2½ to 3 in. steel lap welded	42%	27%	45½%	20½%	53½%	41%

Malleable fittings. Class B and C, from New York stock sell at list + 12½%.

Cast iron, standard sizes, 10% off

BOILER TUBES—The following are the prices for carload lots, f. o. b. Pittsburgh:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in	40½	3½ to 4½ in	15½
2½ to 3¼ in	30½	3 to 3¼ in	1
2¼ in	24	2½ to 2¾ in	+ 1
1¾ to 2 in	19½	2 to 2¼ in	+16
		1¾ to 1⅞ in	+29

Standard Commercial Seamless—Cold Drawn or Hot Rolled

	Per Net Ton		Per Net Ton
1 in	$327	1¾ in	$207
1¼ in	267	2 to 2½ in	177
1⅜ in	257	2¾ to 3¾ in	162
1½ in	207	4 in	187
		4½ to 5 in	207

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation

ELECTRICAL SUPPLIES

ARMORED CABLE—

B.&S. Size	Two Cond M Ft.	Three Cond. M Ft	Two Cond. Lead M Ft.	Three Cond. Lead M Ft
No. 14 solid	$104 00	$138 00	$164 00	$210 00
No. 12 solid	135 00	170 00	225 00	2[illegible].00
No. 10 solid	185 00	235.00	275 00	325 00
No. 8 stranded	285 00	375.00	520 00	500 00
No. 6 stranded	400 00	500.00	560 00	. . . . .

From the above lists discounts are:

Less than coil lots	Net List
Coils to 1,000 ft	10%
1,000 ft. and over	15%

BATTERIES, DRY—Regular No. 6 size red seal, Columbia, or Ever Ready

	Each, Net
Less than 12	$0 40
12 to 50	38
50 to 125 (bbl.)	35
125 (bbl.) or over	.32

CONDUITS ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per 100 for couplings and elbows:

	Conduit		Elbows		Couplings	
Size, In.	Black 1,000 Ft. and Over	Galvanized 1,000 Ft. and Over	Black 100 and Over	Galvanised 100 and Over	Black 100 and Over	Galvanised 100 and Over
⅜	$71 15	$76.25	$17.04	$18.18	$5.38	$5.74
½	71 15	26 25	17 04	18.18	6.28	6.70
¾	93.96	100 86	22.43	23.93	8.97	9.57
1	138.39	149.09	33.19	35 41	11 66	12.44
1¼	182.91	201 71	42 62	45.31	16.10	17.12
1½	224 68	241 18	56 82	60.62	19.89	21.15
2	302.29	324 49	104 17	110 77	26 52	28.20
2½	477.95	513 05	170.46	181 26	37 88	40.28
3	625 00	670 91	454.56	483 36	56.82	60.42
3½	779 24	834 44	1,003.82	1,067.42	75 76	80.56
4	945 03	1,010 43	1,160.08	1,233 52	94 70	100.70

5% cash 10 days.

From New York Warehouse—Less 5% cash.

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.	
[illegible]	250	$0.05½	Coils. 55% off Less coils, 46% off
[illegible]	250	.06	
[illegible]	250	.09	
[illegible]	200	.12	
[illegible]	200	.15	
[illegible]	150	.18	
1	100	.25	
1¼	100	.33	
1½	Odd lengths	.40	
2	Odd lengths	.55	

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0 11	T. P. to D. P. S. B	$0 24
D. P. M. L.	.18	T. P. to D. P. T. B	.38
T. P. M. L	.26	T. P. S. B	.33
D. P. S. B	.19	T. P. D. B	.54
D. P. D. B	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L	$0 33	$0 84	$1 68
T. P. M. L.	48	1 20	2 40
D. P. S. B	.42	1 05	. . .
T. P. S. B	.81	1 80	. . .
D. P. D. B.	.78	2 10	. . .
T. P. D. B	1 35	3 60	. . .
T. P. to D. P. D. B	90	2.52	

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$16.75
No. 16 cotton twisted	22.00
No. 18 cotton parallel	19.80
No. 16 cotton parallel	25.75
No. 18 cotton reinforced heavy	30.00
No. 16 cotton reinforced heavy	36.50
No. 18 cotton reinforced light	23.40
No. 16 cotton reinforced light	27.50
No. 18 cotton Canvasite cord	26.00
No. 16 cotton Canvasite cord	28.50

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List
3-amp. to 30-amp	100	$0.25
35-amp. to 60-amp	100	.35
65-amp. to 100-amp	50	.90
10-amp. to 200-amp	25	2.00
15-amp. to 400-amp	25	3 60
2-amp. to 600-amo.	10	5.50

600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	.40
35-amp. to 60-amp.	100	.60
65-amp. to 100-amp.	50	1.50
110-amp. to 200-amp.	25	2.50
225-amp. to 400-amp.	25	5.50
450-amp. to 600-amp.	10	8.00

Discount:	
Less 1-5th standard package	30%
1-5th to standard package	40%
Standard package	52%

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package	$4.75 C
0–30 ampere, less than standard package	6.00 C

LAMPS—Below are present quotations in less than standard package quantities.

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B— Watts	Plain	Frosted	No. in Package	Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.35	$0 38	100	75	$0 70	$0 75	50
15	35	.38	100	100	1 10	1 15	24
25	35	.38	100	150	1 65	1 70	24
40	.35	.38	100	200	2 20	2 27	24
50	.35	.38	100	300	3 25	3 35	24
60	.40	.45	100	400	4 30	4 45	12
100	85	.92	24	500	4 20	4 85	12
				750	6.50	6 75	8
				1000	7.50	7 75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list

PLUGS, ATTACHMENT—

		Each
Hubbell, porcelain No. 5406,	standard package 250	$0 24
Hubbell composition No. 5467,	standard package 50	.32
Benjamin swivel No. 903,	standard package 250	.20
Hubbell current taps No. 5638,	standard package 50	.40

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$12 00	$14 00	$13 90	$25 00
12	13 25	15 20	18 05	30 70
10	18 30	21 00	23 85	41 50
8	25.54	28 60	32 70	56 77
6	. . . .	. . . . . .	51 40	. . .
4	. . . .	. . . . . .	70 00	. . . . .
2	. . . .	. . .	101 80	. . . . .
1	. . . .	. . . . . .	131 86	. . . . .
0	. . . .	. . . . . .	160.00	. . . . .
00	. . . .	. . . . .	193 50	. . . . .
000	. . . .	. . . . . .	235 20	. . . .
0000	. . . .	. . . . . .	288 60	. .

Prices per 1000 ft. for Rubber-covered Wire in Following Cities:

	Denver			St. Louis			Birmingham		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$15 00	$16 00	$34.00	$16 00	$21 00	$33.00	$11 50	$15 25	$30.33
10	17.65	24 25	48.00	27 20	31 00	69 00	33 81	24 25	55 08
8	24.50	31.75	66.00	38 00	42.00	78 00	47.02	32 60	74 61
6	38.65	42 25			65.00	130 00	65 94	54 25	
4	54 35	58 95	. . .	.	93 00		91 70	73 75	.
2	80.85	86 15	. . . .	. . .	140 00	. . .	130.97	104.50	
1	100.05	113.10	. . . .	. .	182 00	. . . .	172 38	136 40	. .
0	. . . . . .	158.00	. . . .	. . . .	242.00	. .	204.51	174 60	. .
00	. . . . .	183.60	. . . .	. . . .	290 00	. . .	251.94	214.00	. . . .
000	. . . . . .	222.80	. . . .	. . . .	360 00	. . . .	306 1	257 50	. . . .
0000	. . . . . .	269.70	. . . .		435 00	. . . . .	371.38	308 50	. . .

Pittsburg—23c. base; discount 50%

SOCKETS, BRASS SHELL—

¼ In. or Pendant Cap.			⅜ In. Cap		
Key, Each	Keyless, Each	Pull, Each	Key, Each	Keyless, Each	Pull, Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0 66

Less 1-5th standard package	+20%
1-5th to standard package	+10%
Standard package	−15%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B.&S. regular spools (approx. 8 lb.)	36c. lb
No. 18 B.&S. regular 1-lb. coils	37c. lb.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 50c. lb., 100 lb. lots	48c. lb.
Rubber tape, ¾ in., less 100 lb., 65c. lb., 100 lb. lots	60c. lb.
Wire solder, less 100 lb. 50c. lb., 100 lb. lots	46c. lb.
Soldering paste. 2 oz. cans Nokorode	$1.20 doz.

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$0 42	$0 68	$1.02	$1.36
60	.74	1.22	1.84	2 44
100	1 50	2.50	3.76	5.00
200	2.70	4 50	6 76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole Each
30	.70	1 06	1.60	2 120
60	1 18	1 80	2.70	3.60
100	2.38	3 66	5.50	7.3
200	4 40	6.76	10 14	13.50

Discounts:

Less than $10.00 list value	+ 5%
$10 to $25 list value	— 8%
$25 to $50 list value	—15%
$50 to $200 list value	—20%
$200 list value or over	—25%

POWER

Volume 50 New York, August 12, 1919 *Number* 7

Work-a Source of Contentment

By J. J. Jahobart

WORK, according to Webster, is physical or intellectual effort directed to accomplish an objective. The mechanical definition of the word is, the overcoming of resistance continually occurring along a line of motion.

Work, according to some fellows, is nothing more nor less than slavery. They consider it a contemptible law of humanity, imposed upon a multitude of abject fellow-beings by a certain few who revel in their ill-gotten wealth, supposedly accumulated through the unappreciated efforts of their less fortunate fellows. And so it is, that far too many of us have a distorted, warped conception of the real reason for work.

But why look at work with the twisted idea that you are being imposed upon, if you are by the nature of things compelled to earn your daily sustenance by honest labor? Surely, it is no dishonor to have to do one's share of the work required to make this old world a decent place to live in. And if you don't find it a reasonable place to live in, it is no one's fault but your own. It is your fault to the extent that you listen to the wrong side of the issue.

You cannot add unlike numbers, such as six marbles and six oranges, and get twelve peaches out of it, but you can add six industrious workers and six indifferent drifters and get a dozen poor workers, so far as total results are concerned. Why? Because it is invariably an easy matter for the indifferent fellow to sow the seeds of discontent and doubt in the mind of his fellow-workmen. His slogan is "GET all you can with the least effort," and this same fellow makes more noise than all the rest of the crew, when the salary increases and promotion slips pass him up.

Work is not alone the safety valve for accumulated energy. It should be a source of pleasure and contentment Whether the job is holding you or whether you are holding the job depends upon your state of mind, and the morale of a working force, an army or a baseball team depends upon its state of mind. The pity of it is that one casehardened shirker and kicker among the employees can do more to lower this standard than almost any other agency.

Did you ever go to work in the morning feeling like you owned the universe? Just running over with "pep"? Just when you get your day's work organized, some fellow comes along and spills his tale of misery, and after listening a few minutes, you begin to feel as though you would like to go home. You are lucky if this has not happened to you. But without doubt it has, therefore you know by experience how dangerously contagious such misdirected suggestion is to the man who really wants to GET AHEAD, and knows the value of work.

Low Temperature Distillation of Coal

By C. M. GARLAND
Consulting Engineer, Chicago, Ill.

Various methods of distilling coal at temperatures averaging 900 deg. F. Coke produced is a clean, smokeless fuel suitable for domestic and small power use. Byproducts recovered per ton of bituminous coal are 20 to 30 gal. of tar valued at 10c. per gal. and 12 lb. of ammonium sulphate worth 3c. per lb. For power plants with constant load burning over 50 tons of coal per day, a combination of the low-temperature process with a byproduct gas producer to recover a much greater percentage of ammonium sulphate offers remarkable advantages for improving economy. The byproducts pay for the coal, the overhead and operating expense, and the gas, containing about 70 per cent. of the heat in the coal and burning at higher efficiency, is available for fuel under the boilers or for direct use in gas engines.

LOW-TEMPERATURE distillation of coal is carried out in closed retorts at temperatures ranging from 700 to 1200 deg. F., as opposed to high-temperature distillation, common in coal gas and byproduct coke-oven practice, where the coking temperatures vary between 1800 and 2500 deg. F. The effect of this difference in coking temperature is very marked on the coke produced and also on the byproducts. The high-temperature process produces a dense, hard coke that is highly adapted to blast-furnace and foundry practice where forced blasts are used to produce high temperatures. The high ignition point and the high draft required to maintain a fuel bed have tended to render the use of this fuel somewhat unpopular as a domestic product.

While the low-temperature coke is a much softer product, it has sufficient mechanical strength for all practical purposes, possesses a low ignition point, permits the maintenance of a fuel bed under low draft and burns without smoke notwithstanding the fact that it is commonly sent out with from 3 to 18 per cent. volatile remaining in it. The mechanical strength of this material is not sufficient for it to sustain a furnace burden, and for this reason it is not suited to metallurgical operations as a rule.

Between the byproduct from the high- and low-temperature distillations the difference is even more marked than in the respective cokes. From the high-temperature distillation, as carried out in coal-gas and byproduct coke-oven plants, from 8 to 15 gal. of tar per ton of coal is produced as compared with 20 to 30 gal. per ton from the low-temperature process. The high-temperature tar is a black, gummy mass having a specific gravity of about 1.2 and containing from 60 to 80 per cent. pitch and free carbon. This tar sells at from 2 to 3½c. per gal. The low-temperature tar contains from 30 to 40 per cent. pitch and free carbon, a large percentage of tar acids suitable for wood preservation, etc., together with low-boiling distillates suitable for motor fuel. The specific gravity is about 1.07, the color dark brown and the consistency about the same as a heavy machine oil. Investigations indicate that this tar at the present time has a value close to 10c. per gal. in the crude state.

In the low-temperature process the temperatures are too low for a large yield of ammonium sulphate. Twelve pounds per ton of coal as compared with 20 to 35 lb. for the high-temperature process is representative. The volume of gas produced is also small and will vary from 1000 to 4000 cu.ft. per ton of coal as compared with from 10,000 to 12,000 cu.ft. for high-temperature distillation. This low-temperature gas has a caloric value of from 750 to 1000 B.t.u. per cubic foot as compared with from 500 to 600 B.t.u. for the high-temperature gas.

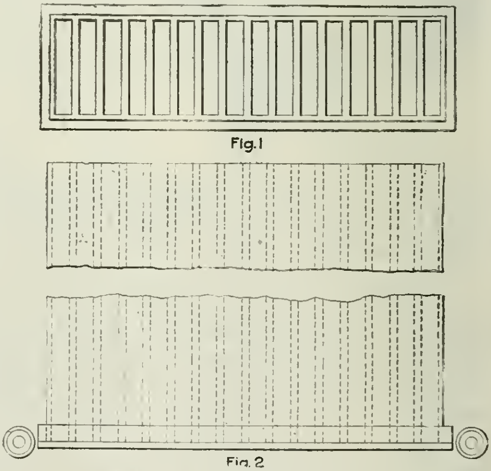


FIG. 1. PLAN VIEW OF TRAER RETORT. FIG. 2. SIDE ELEVATION OF TRAER RETORT

On the byproducts from coal the general effects of low-temperature distillation have been known for a great many years. The value of the process as a means for the production of a clean, smokeless fuel possessing a low ignition point together with the recognition of the possibilities in the use of the byproducts has been growing in the minds of investigators along these lines for the last 15 years. The English have been most active, and several schemes for carrying out this process have been brought out and some have reached the commercial stage.

In this country Parr, at the University of Illinois, began in 1906 some experiments which have been continued up to the present time. Also there have been several schemes for the carrying out of the low-temperature process on a commercial scale suggested by different investigators in this country. The most promising of these schemes at the present time are the ones brought out by G. W. Traer, of the Universal Coal Products Co.; "Carbocoal," as brought out by Charles H. Smith and financed by Blair & Co., of New York; the G. & L. process, brought out by Greene & Laucks, of Denver; and the process brought out by Bostaph.

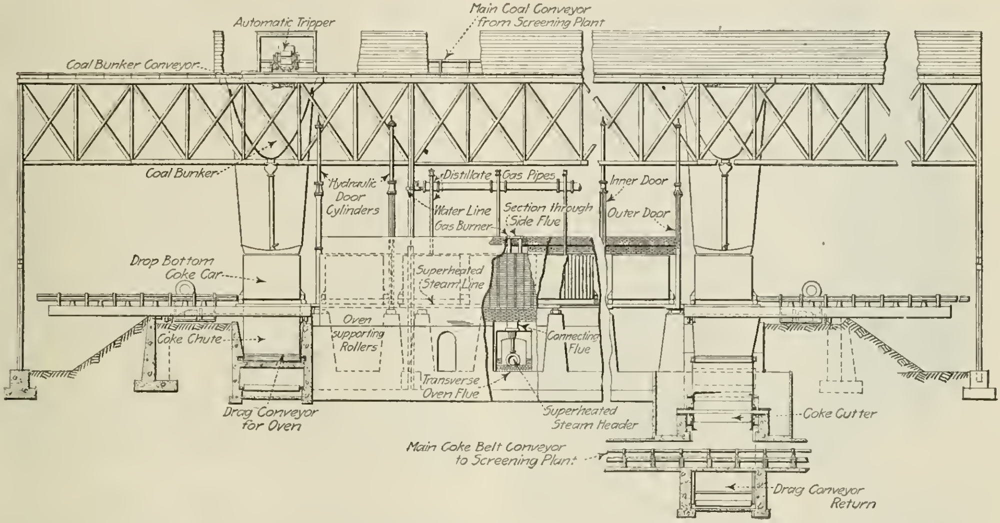


FIG. 3. SIDE ELEVATION IN PART SECTION OF THE OVEN THROUGH WHICH THE RETORTS ARE PUSHED

In carrying out the low-temperature process, one of two general schemes may be used—either the coal may be crushed and then charged into forms or retorts in which it is coked, or the coal may be coked during its passage through some form of retort in which a screw or propeller is used to push the coal forward as it undergoes coking. In the latter scheme the finished byproduct must be briquetted if it is used for domestic purposes. In the former the coke comes out in a molded form and must be crushed for market.

In the processes of Traer and Bostaph the coal is coked in cast-iron forms. In the Traer process, which has developed under the writer's supervision, the coal is charged into a vertical form which is divided by partitions to produce rectangular slabs of coke about 1 x 12 in. in cross-section by about 6 ft. in length. Sixteen of these slabs are produced in one form. The forms are provided with drop bottoms and are mounted on trucks. The coal is coked in these forms by being slowly moved through an oven which is heated by side flues.

Fig. 1 shows a plan view of the Traer retort, Fig. 2 a side elevation and Fig. 3 a side elevation in part section of the oven through which the retorts are pushed. These ovens are approximately 100 ft. long and are equipped at each end with two hydraulically operated doors. These doors form a lock through which the retorts are pushed to and from the ovens without the escape of gas.

These retorts are handled with a combination "puller and pusher," electrically operated, which runs on a track, one at each end of the group of ovens. They push the freshly charged retorts into the oven at one end and pull them out at the opposite end. The retorts are filled from an overhead coal bin and are charged at one end of the oven, discharged at the opposite end, recharged and sent through the adjacent oven. The ovens are therefore operated in pairs. An overhead coal bin extends across each end of the ovens, also a conveyor for receiving the coke extends across each end of the ovens onto which the coke from the retorts is dropped. The coke is quenched while on these conveyors and is transferred to a belt conveyor which delivers it to the crushing and screening plant. A photograph of a piece of coke produced is shown in the headpiece to this article.

In the Bostaph arrangement the coal also is coked in the form of slabs, but these slabs form segments of a cylindrical drum which is provided with a hollow core for drawing off the products of distillation. Fig. 4 is a cross-section of the Bostaph retort. The heat is supplied externally, and the products of distillation pass through perforations in the inner wall of the retort to the central core, the idea being that the products of distillation will never come into contact with a higher temperature than that from which they are distilled. This prevents the breaking up of the products, which occurs whenever they are brought into contact with surfaces of a higher temperature. In the Traer process this is accomplished by drawing the gases off the tops of the retorts immediately after they are generated.

In the low-temperature process, where the coking is carried on in fixed retorts of the Traer and Bostaph types, the coal must be coked in thin layers to produce a uniform product. This means that the coal and coke must be handled in small quantities. The problem in the design of such plants is therefore to keep down the cost of handling. It is the opinion of the writer that the Traer process has a lower operating cost per ton of coal handled than any of the plans proposed up to the present time.

Keeping Down the Costs

In the Smith process the coking is carried out in two stages. The coal to be coked is first forced through a retort by means of a screw or propeller. The retort is maintained at a temperature of about 900 deg. F. The coke discharged from this retort is in a finely divided conditon, not well adapted for domestic distribution. It contains a comparatively large percentage of volatile and, after it leaves the first retort, is mixed with a certain percentage of pitch and then briquetted. The briquets are subjected to a temperature in the neighborhood of 1800 deg. F., which cokes the pitch and drives off most of the volatile remaining in the coke from the first distillation.

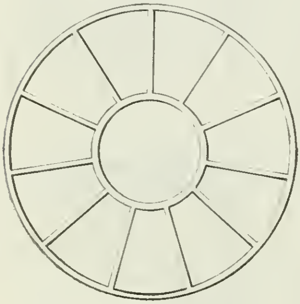


FIG. 4. CROSS-SECTION OF BOSTAPH RETORT

In the G. & L. process a vertical retort is used that contains propellers for forcing the coal through the retort. These propellers are mounted on a hollow shaft, and the products of distillation are drawn out through this shaft. In this process the coke produced is not as yet briquetted. Undoubtedly, briquetting will have to be resorted to in order to produce a satisfactory fuel for household use.

Advantages of Traer and Bostaph Processes

The Traer and Bostaph processes have an advantage in that the operating cost and the first cost of the plant are much lower than is possible with a plant employing the briquetting process. The coke produced from these processes, while it does not possess the mechanical strength of the briquetted product nor the density, is an excellent domestic fuel and can undoubtedly be burned with a much lower draft. The fuel produced by the Smith process is an excellent one and possesses the advantage just referred to, of greater mechanical strength, but must necessarily sell for a much higher price.

From all these processes the fuel produced is highly adapted for domestic use and for small power work. They are essentially processes for the manufacture of a clean, smokeless, domestic fuel, suitable for replacing anthracite, semi-anthracite and hard coke. The processes possess possibilities, however, for use in connection with large power work and the writer is of the opinion that ultimitely a large portion of the coal used in the generation of power will be subjected to some such process for the removal of the tar and ammonia.

From the low-temperature process the tar yields a large quantity of oil suitable for motor fuel. It is also possible to crack this tar and produce a much larger quantity of motor fuel. From our knowledge of the cracking process at the present time, it would not seem impossible to obtain from 15 to 20 gal. of motor spirit per ton of bituminous coal gasified. In addition to this, by the low-temperature process from 12 to 20 lb. of ammonium sulphate may be obtained.

Fuel Oil From Low Temperature Process

There is, however, a still greater development which must ultimately result from this line of investigation, and that is a combination of this low-temperature process with the byproduct recovery gas producer for use in the generation of power. In the byproduct gas producer, as exemplified by Mond, the coal is gasified in a special type of producer in which a large quantity of superheated steam is mixed with the blast. The result is that a large amount of ammonia is formed by the superheated steam from the nitrogen contained in the coal. This ammonia is recovered by scrubbing the gas with dilute sulphuric acid in the form of ammonium sulphate. By the Mond process from 50 to 110 lb. of ammonium sulphate may be recovered per ton of coal, depending upon the percentage of nitrogen in the coal. Ordinarily, this ammonium sulphate has a value of about \$60 per ton. Under present prices the value is close to \$90 a ton, or about 4½c. per lb. It may be safely stated that for average conditions ammonium sulphate will have a net value of around 3c. a lb., so that the byproduct of ammonium sulphate will have a value of from \$1.50 to \$3.30 per ton of coal gasified.

The Mond Process in Europe

In Europe the Mond process has been used with a fair amount of success simply recovering the ammonium sulphate. The tar recovery from this process has been of little or no value, principally for the reason that the tar consists of from 75 to 85 per cent. of free carbon and pitch. By combining the Mond process with some modification of the low-temperature process, from 20 to 30 gal. of tar can be obtained per ton of coal having a value in a crude state of around 10c. per gal., or a value of from \$2 to \$3 per ton of coal gasified.

By the combination of these two processes byproducts may be obtained having a total value in the crude state of from \$3.50 to \$6.50 per ton of coal gasified. Undoubtedly, herein lies one of the largest possibilities in the power field. There are many large concerns that have spent hundreds of thousands of dollars trying to decrease the coal bill 5, 10 or 15 per cent. Binary vapor engines, high-compression internal-combustion engines and many other schemes have been tried in an attempt to reduce the cost of power. By the combination of the low-temperature distillation process with the Mond process the coal bill under proper conditions can be eliminated entirely.

Installations of this character are, however, only adapted to plants using 50 tons or more of coal per 24 hours. The operation also must be continuous 24 hours per day and preferably 360 days per annum. The gases from the byproduct producers can be used for the generation of steam under boilers and this steam used in turbines for the generation of power, or they may be used direct in internal-combustion engines. Plants of this type also are highly adapted for use in steel mills, glass works and the ceramic industries for supplying a clean, cold gas that can be piped in small mains practically any distance up to 25 or 30 miles. For steel mills where coke is not required, this type of plant offers much greater possibilities than the byproduct coke oven.

A plant using as much as 50 tons of coal per day with an ammonium-sulphate recovery of 85 lb. per ton of coal, will generate power and just about eliminate the coal bill. In a larger-sized plant the returns from the byproducts will eliminate not only the coal bill, but also the cost of operation, including the fixed charges on the investment. With a still larger plant the operating costs can be eliminated and there may be a small surplus after the disposal of the byproducts.

CONTINUOUS OPERATION NECESSARY

In a plant of this character, however, the operation must be to all intents and purposes continuous, and the load factor should not be under 75 per cent. if the byproduct installation is designed to take care of the total power or gas output.

The natural question arises as to why plants of this character have not already come into use in this country to some considerable extent. The answer is that a number of reasons have delayed the development of this type of plant. In the first place the early attempts to use American coals in the Mond producer have not met with a very high degree of success. This has been due to insufficient knowledge of American fuels and their proper operation in byproduct gas producers. In addition to this the byproduct plant takes much space, requires the services of chemists, is costly to install and requires considerable labor in its operation.

The byproduct producer alone, which recovers only ammonium sulphate, did not promise sufficient to warrant the manufacturers, under ordinary conditions, resorting to this large outlay and embarking in a new business, in order to reduce the fuel bill. With the development of a low-temperature distillation process the combination of this process with the byproduct gas producer more than doubles the value of the byproduct, which unquestionably will now make the installation of plants of this character a more promising undertaking.

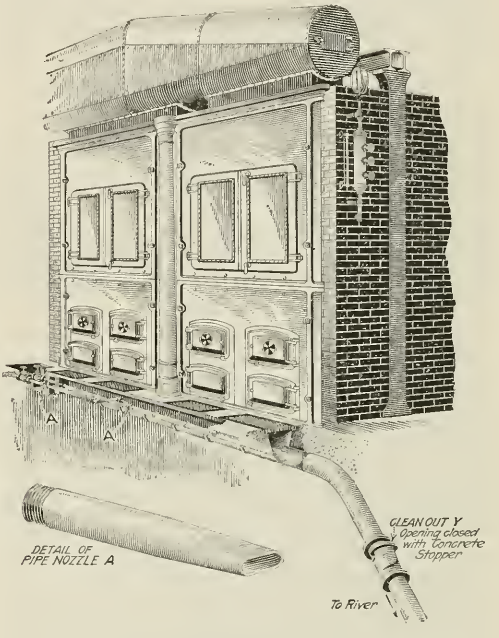
Ash-Sluicing System*

The illustration shows an arrangement for disposing of the ashes in a small electric-lighting plant. The installation consists of two 72-in. x 18-ft. return-tubular boilers that have two fire-doors each and are hand-fired with the usual run of small coal. The ash content of the coal varies from 15 per cent. to 25 per cent., and naturally there is a fairly large quantity of ash.

Previous to the installation of this equipment the ash was handled by means of wheelbarrows, entailing considerable expense. The arrangement illustrated consists merely of a sluicing trough of concrete across the front of the boilers, the bottom of the trough being lined with semicircular vitrified-tile pipe. A water jet is placed in front of each boiler in the position shown, and is fitted with the necessary operating valve.

The ash duct is covered by small concrete slabs, except in front of each ashpit door, where a cast-iron grating is located. The ashes are sluiced down by means of the water jet, and a 10-in. vitrified-tile pipe is connected to the end of the trough and carried away to the place where the ashes are to be deposited—in this case to the bank of a near-by river. Clean-out Y's are placed in the line of tile pipes to facilitate the removal of obstructions that may occur.

The trough is given a fall of one-half inch per foot, which is found in practice to be quite ample to carry away clinkers of any reasonable size. This slope could be varied from one-fourth inch per foot to three-fourths inch per foot, as desired. Quick-opening valves are desirable, although not absolutely necessary.



SLUICING ARRANGEMENT IN FRONT OF BOILER FOR ASH DISPOSAL

The cast-iron grating is provided with a sheet-steel cover that is held to the grating by means of two straps fitted to hinge pins cast into the grating, so that the cover may be lifed from either side or removed entirely when desired. In the case of hand-fired boilers it is desirable that the gratings be covered when the boilers are fired, to prevent the loss of coal due to spillage. When raking ashes from the ashpit, the cover would be lifted toward the fireman, so that the ashes could be raked on to the grating.

Any large clinkers that are pulled out of the ashpit have to be broken through the grating. This does away with pieces of clinker too large to be carried off by the sluicing trough. The ribs of the grating are made with the upper edges tapered in order to facilitate the breaking of the clinker.

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*From data furnished by Frank Sawford, Taylor Engineering Company, Vancouver, B. C., Canada.

Physical Tests of Boiler-Steel Plates

By FREDERICK BIGGAM
Inspector of Steam Boilers, Provincial Government Office, Vancouver, B. C.

BRITISH Admiralty regulations stipulate that strips shall be cut from every plate proposed for boiler construction crosswise as well as lengthwise, 1½ in. wide, heated uniformly to a low cherry red and cooled in water of 82 deg. F. Such strips must stand bending in a press to a curve of which the inner radius is 1½ times the thickness of the steel tested.

The regulations of the British Board of Trade are the same as those of the Admiralty with the exception that strips are not required crosswise; that is, in the direction of the shorter dimension. Lloyds Registry and the Bureau Veritas have substantially the same requirements as the Board of Trade. So also have the Massachusetts Boiler Rules, except that the latter insist on one cold and one quenched specimen from every plate.

In Canada, where the rules of the British Columbia Boiler Act constitute the most rigid, and probably set the highest, standard of the Dominion in boiler construction, the requirements are practically the same as those of Lloyds or the Board of Trade, so that in regard to the fitness of material for boiler work, it may be stated with all propriety that the several inspection bureaus, representative of the best modern practice, unite in declaring the bending test a necessary and a searching probe in the hunt for reliable materials of construction.[1]

THE INSPECTOR IS FREQUENTLY PUZZLED

The purpose of what follows here is not intended to disparage or belittle the valuable information that may accrue from properly conducted bending tests. It will be rather an endeavor to show that despite the persistence with which the time-honored bending tests recur in amended rules of inspection societies, these tests, to the wayfaring engineer, have not the finality that such persistence would seem to imply. Indeed, the surveyor—if he is of an engineering turn of mind—whose daily work engages him in witnessing bend tests, is often given "furiously to think" when brought face to face with certain phenomena in the behavior of steel under inspection. And he would be a bold man who would unhesitatingly scrap a plate because a random strip sheared from a corner showed the forbidden flaw. Equally daring would it be to classify as faultless material a sheet the best strip from which had bent gracefully over without a hair-line crack. As a matter of fact, the experienced inspector not infrequently finds himself puzzled to determine how far the interests of public safety may be stretched in order that a most whimsical material of construction may be harnessed for the public service.

Here is a record from actual experience. A number of $\frac{7}{16}$-in. boiler plates are laid out in order for testing. Every plate has its test-strip sheared or sawn to the regulation length, which is roughly seventeen times the thickness. These strips, after being marked for future identification, are broken from the plates. A little rounding of the edges prepares them for the bending cold test. Probably several of the sheets are of the same charge and have the same melt number stamped on. However, as the rules ignore any presumption of identical properties, every plate contributes its specimen strips.

The tests proceed and one unfortunate strip develops a pronounced flaw. It is identified as belonging to a particular plate with a certain melt number, and that plate's reputation is in jeopardy. The remaining strips are heated without mishap and then the results are adjudicated upon. It is found that the suspicious plate has the same melt number as two other plates, the test strips from which behaved quite normally. Here is food for thought, and the investigation of the apparently bad plate is carried a little farther. The failed specimen is pried apart and broken at the point of flexure. The two pieces, although now far too short for the orthodox bending tests, are given a chance to palliate the failings of the parent plate. One is bent in the same direction as the original strip and, as would be expected, it fails in the same manner as before. But the other is bent in the opposite direction to the original strip and it performs the feat without "turning a hair"! Finally, we go back to the now not so suspicious plate, and shear a properly dimensioned specimen from the same region as before. Care is taken to bend it in the direction opposite to that in which the first strip was bent, and again its behavior is above reproach. Now, is this particular plate unsuitable for boiler-construction purposes? And could this uncanny behavior be construed as satisfying the bending-test requirements of the inspection authorities?

It might be contended that this was only a coincidence, but the record is not one of an isolated case. Such phenomena have so frequently recurred in my personal experience that some other explanation than mere coincidence is needed. It should be clearly understood that the foregoing refers to the ordinary mill run of boiler steel of 55,000 to 65,000 lb. tensile strength, usually stamped at two places on every plate.

BOILER PLATE FIBROUS IN TEXTURE

The properties of steel form a highly technical subject that is outside the scope of this article. It may be said, however, that the material at the disposal of the boilermakers is to a certain extent fibrous in texture. This property may not inhere in the ingot, but is induced by the process of rolling from ingot to plate. At all events, the ordinary boiler plate is fibrous, as is quite plain when a failed test specimen is examined under a magnifying glass. It is also generally conceded that the grain or fiber is induced in the direction of rolling, which direction is the longer dimension of the plate as delivered to the boiler shop.

The experience of boiler-inspection bureaus seems to connect very decidedly the longer dimension of a plate with the run of the fiber or grain. Records of the Hartford Company abound in instances of failure of horizontal return-tubular boilers with the shell plates curved by the boilermaker in the direction of the shorter dimension, thus eliminating the middle circumferential seam, but having the two longitudinal seams running the entire length of the steel, one on each side. Similar has been the experience of the British Columbia Inspection Board. Indeed, a registered design for logging boilers of this objectionable mode of construction had to be withdrawn because of disastrous explosions in the case of two boilers and timely detection of dangerous grooving in several others.

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[1] For the provisions of the Boiler Code of the American Society of Mechanical Engineers see the editorial on page 268.—EDITOR.

From the experiences noted it seems safe to assume that the rectangular plates supplied to the boilermaker are fibrous in the direction of their greater dimension, and further, that the boilermaker who ignores this in shaping the plate to the curvature of a boiler shell really maltreats his material when he bends it in the direction of its shorter dimension. In effect, he opens the grain and creates incipient grooves or cracks, which small beginnings develop quickly when the boiler is put into operation. Perhaps it should have been mentioned, in regard to the series of logging-engine boilers of British Columbia design, that consequent to their ill fortune a more stringent bend test, similar to the British Admiralty requirements, was enforced. The alarmingly high percentage of failures of crosswise strips was such that this practice had to be abandoned. The material concerned was the ordinary boiler plate secured from the various reputable steel mills of this continent.

Rolling Induces a Fibrous Texture in the Direction of Rolling

If, then, there are strong reasons for concluding that from an ingot nonfibrous in texture the process of rolling to plate form induces a fibrous texture in the direction of the rolling, may the conjecture not be hazarded that there are other effects due to the same process? When dealing with an admittedly mysterious and illusive chemical compound like steel, a little speculation in a guarded way may be permissible, with the object, in this instance, of finding a possible explanation of the sometimes marked difference in behavior of test strips from the same plate when bent in opposite directions.

The problem may be stated in a general way thus: Are the molecules on one side of the neutral axis of a steel plate so arranged that tension can be withstood better than by the molecular structure on the opposite side of the neutral axis, and vice versa in regard to compression? And does the process of rolling from ingot to sheet support such a hypothesis when the process is minutely subjected to systematic observation, taking cognizance of the thermal conditions of ingot and rolls relatively from start to finish, the forces that cause the rolls to rotate and whether these forces possibly tend to put more work into one side of the sheet than the other? The remedy for the latter would be a highly complex machine that would automatically flip, or turn upside down, the embryo plate at every reversal of its movement between the rolls. The investigation might with advantage follow the finished plate to the pile to see what influence its fellows in a different thermal state might exert there.

This opens a wide field of inquiry that could be undertaken only by the expert thoroughly conversant with steel rolling-mill practice. Probably the voluminous literature of steel making contains something in regard to these points; but after fairly wide reading, reference to the deleterious effects of careless piling of the finished plates is the only one that comes to mind. If the phenomena specifically mentioned have been to any extent discussed, such discussion has not received the publicity it deserved and it would undoubtedly be welcomed by all parties concerned, especially the users of such plates.

The famous Disraeli epigram, "What is new is not true and what is true is not new," may be applied to these notes by the erudite metallurgical specialist; but when the great masters of the subject, like Williams, Hadfield and others, use the word "mysterious" in regard to steel phenomena, the smaller thinker may be excused for putting forth a query respecting queer happenings that have chanced experimentally within his own ken.

By way of emphasizing the fact that, in steel, surveyors, inspectors and engineers handle an extremely whimsical form of matter and that to dogmatize on the sufficiency of the physical tests prescribed by the rules of the superior authorities may lead away from the interests which those rules are intended to conserve, let me conclude with an account from the Dec. 11, 1914, issue of London *Engineering*.

Remarkable Failure of Steel Ship Plates

The record is one describing the remarkable failure of a consignment of steel ship plates. The material had been classed as excellent by Lloyds' surveyor in that it had fulfilled all requirements of the rules as regards testing. After having been flanged and riveted in place near the keel, cracks in profusion developed between rivet holes and from holes to edges of plates. All the plates of that charge were of necessity replaced by others. The case was referred to high authority in the person of Prof. J. O. Arnold, of Sheffield University, who, from analysis, concluded that the steel was "not of very good quality." From micrographic examination the material appeared to have been "overheated in the manufacture and gravely injured by the operation." Under alternating-stress tests conducted according to the Sheffield University standard, the results were "extremely unsatisfactory."

The following quotation from such an authority contains something very pertinent to what was intended to be the gist of these notes. He says in the report: "This is the worst steel of its class I have ever examined under alternating stress. I have not had the tensile tests made, as in such cases these would be of very little use, usually giving very fair results. As regards the bends, I send also three of the bars used in the alternating-stress tests. As you will see, they have bent double without any sign of a flaw. This also is quite usual." All of which seems to spell confusion worse confounded as regards physical tests for steel plate, with perhaps the alternating-stress method appearing as the faint silver lining in the cloud. The subject is full of interest, but space forbids further discussion. On another occasion the question of bend tests and the way in which the behavior of test specimens is influenced by process may be further inquired into. The specific mention, for instance, of a "press" in the British Admiralty rules is quite significant and should be rather reassuring to the steel manufacturer who is nervous about the crosswise-strip bend test, in that no time limit for the operation is stated. However, enough has perhaps been suggested by these remarks to disabuse some minds of the delusion that steel is always steel in the figurative sense; and possibly an avenue of thought has been crudely blazed for others to whom these observations are not altogether new.

Cores and Coils for Transformers—II

By ARTHUR PALME
Engineer, Transformer Engineering Department, General Electric Company

Construction and forms of coils used in different types of transformers are discussed. It is shown how the forms of coils have changed to meet the increased capacity and to make possible the insulating of modern high-voltage transformers. The method employed to prevent distortion of the coils due to the tremendous forces set up when a short-circuit occurs is touched upon.

In a previous article the structural details of various types of transformer cores were considered; in this the various types of windings in modern transformer practice will be discussed. As stated in the former article (Aug. 5 issue), the winding of a transformer consists of two sets of coils, called the primary and the secondary. These two windings are electrically insulated from each other and the iron core. Only in very rare cases, that is, in all so-called "auto-transformers," are the two windings electrically connected.

According to the fundamental laws of electrical induction the secondary winding of a transformer will produce a voltage equal to the voltage impressed upon the primary winding divided by the ratio of the number of turns in the two windings. Thus if a transformer steps up 2300 volts to 50,000 and the primary contains 100 turns, its secondary must have 2174 turns, because 50,000 divided by 2300 is equal to 2174 divided by 100.

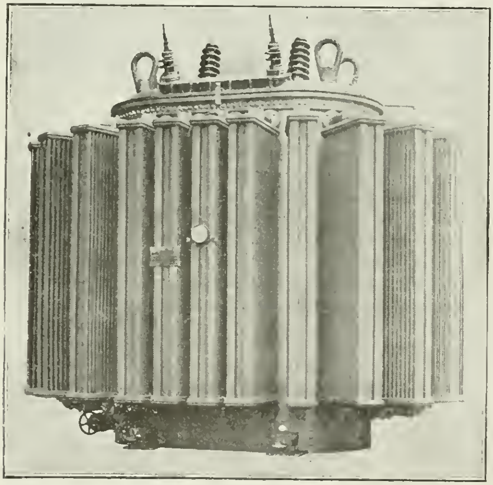


FIG. 1. RADIATOR-TANK TYPE TRANSFORMER

Every transformation of electrical energy will be accompanied by losses which manifest themselves ultimately as heat. As the windings of a transformer cannot be allowed to get hotter than maximum 105 deg. C., or damage to the insulation will result, it is necessary to provide some means to carry away the heat at such a rate as to keep the windings below the critical temperature. A great many cooling methods are being employed, differing according to the size of the transformer and the local conditions. Such cooling methods have been fully described in an article, "Methods of Cooling Transformers," in the Dec. 25, 1917, issue.

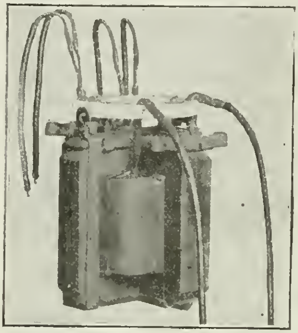


FIG. 2. DISTRIBUTED CORE-TYPE TRANSFORMER

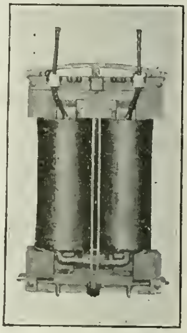


FIG. 3. CORE-TYPE TRANSFORMER

Before starting the design of a transformer, the method of cooling must have been decided upon. This is necessary because the different methods of cooling are capable of carrying away different amounts of heat, so that the smallest allowable cross-section of the conductors in primary and secondary windings depends directly upon the rate of dissipation of heat. In other words, a transformer may be designed with less copper if a quicker cooling method is used. On the other hand, quicker cooling will require a higher mechanical investment, so that it comes finally to a compromise between copper and cooling method.

Increase the Cooling Surface

Most modern transformers are indirectly oil-cooled; that is, the oil is the agent to transmit the heat from the windings to the heat-dissipating medium. As such a medium the tank containing the transformer and the oil may be used, or if its surface should not be sufficient, various methods of increasing it can be employed, such as corrugations, external tubes or radiators. With the last-mentioned method (radiators) enough surface can be obtained to dissipate the losses of even the largest units. An 8000-kv.-a. three-phase 44,000- to 6600-volt radiator-tank type transformer is shown in Fig. 1. However, sometimes the cost of this method or the large floor space required by such a transformer is prohibitive. Then water cooling has to be resorted to, which consists of a steel or copper cooling coil, submerged in the oil, and through which cold water is continually passing.

Every transformer is wound with some form of copper wire. For small output or very high voltage —in other words, for small current—round wire is being used. For larger currents a copper strip enables easier winding and better space economy. Copper-

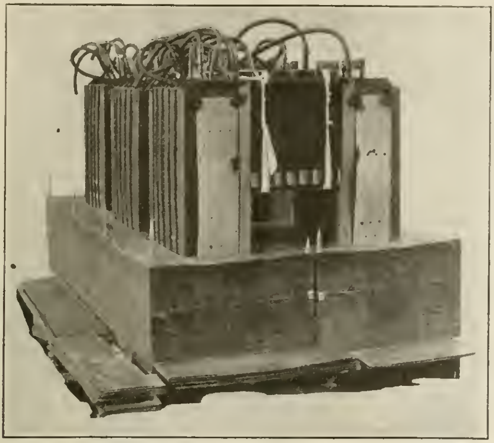


FIG. 4. SHELL-TYPE TRANSFORMER, CORE PARTLY ASSEMBLED ON COILS

rolling mills manufacture such strips in a great variety of sizes, from square to rectangular cross-sections. To insure reliable insulation these cross-sections usually have slightly rounded corners.

A great economy in space has been obtained by winding a rectangular copper strip edgewise. This was found especially valuable on the barrel coils to be mentioned later. It is obvious that by winding a thin rectangular copper strip edgewise a great many turns can be placed in a single layer.

The most important requirement a transformer must fulfill is the safe separation of the high- and low-voltage windings. It can be easily imagined what disastrous consequences would result if on a transformer of, say, 20,000 to 110 volts a connection should be established between these two circuits. In order to safeguard as much as possible against such a breakdown, it is customary to use in all transformers sufficient insulation to stand up under a test voltage very much higher than the rated voltage. On the conductors themselves enamel, cotton and paper are today the most widely used insulating materials. They all withstand any action of the oil, and even when oil-soaked are good insulation. All finished windings should receive a heat treatment with varnish or compound in a good vacuum for many hours, followed immediately by a similar treatment under high pressure. This removes all entrapped air and forces the insulating compound into the windings.

EXPOSE WINDING SURFACE TO THE OIL

The next important requirement is to expose as much as possible of the winding's surface to the oil. In former days, when the output of transformers was not very large and consequently the losses did not amount to much, the cooling of the windings was not difficult.

All types in small sizes, generally using distributed cores, Fig. 2, are wound solid. This means that directly upon the insulated iron core are wound the low-voltage layers, then follow a heavy insulation and the many high-voltage turns. The cooling oil has, therefore, only access to the outer surface of the high-voltage winding. The losses in such transformers amount to such a small amount that they can be easily radiated by the outer surface of the winding alone.

Transformers of larger output are provided with an oil duct between the core and the inner surface of the low-voltage winding and another concentric oil duct between the low-voltage and the high-voltage windings. There are, therefore, four surfaces of the entire winding exposed to the oil. Such a winding is called a concentric or barrel-type winding. The low-voltage winding in this type, placed generally next to the core, consists frequently of one or more cylinders built up of an edge-wound copper strip.

For still higher capacities, additional cooling is necessary; this is obtained by subdividing the high-voltage winding in two concentric barrels, giving a total of six or more cooling surfaces.

Up to about ten years ago core-type transformers with barrel-type windings, Fig. 3, were, in this country, limited to 400 kv.-a. or thereabouts. If larger capacity was desired, it was generally built as a shell-type transformer, Fig. 4. The many thin and long rectangular coils of this design gave a large oil-exposed surface, and consequently enabled the winding to dissipate considerable losses.

CIRCULAR DISK-COIL DESIGN

The present trend is toward another way of obtaining large coil surfaces, and that is the circular-disk coil design, Figs. 5, 6 and 7. As previously shown, additional coil-cooling surface was reached by the barrel-type winding by dividing the necessary number of turns in two or more concentrically arranged cylinders, with oil ducts between them. The principle of the disk-coil winding is the division of the winding in the horizontal way; that is, by building up the entire transformer stack of thin disks with horizontal oil ducts between. This method is sometimes called a "pancake" winding. The height or thickness of each disk is made very small, rarely more than half an inch. In winding with a strip, the thickness of the disk is equal to the long dimension of the strip plus twice the amount of the insulation upon it. Thus every disk represents a spiral,

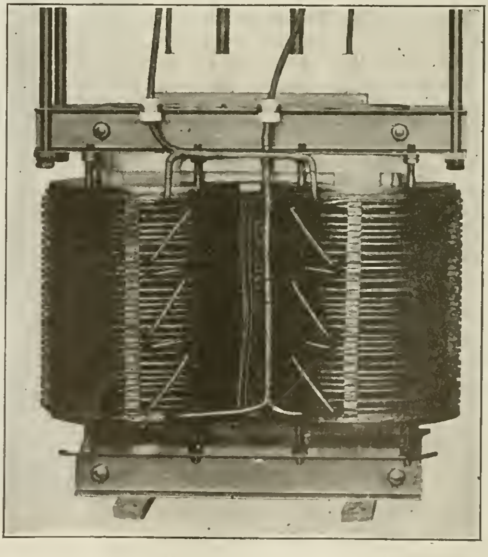


FIG. 5. SINGLE-PHASE DISK-COIL TYPE TRANSFORMER

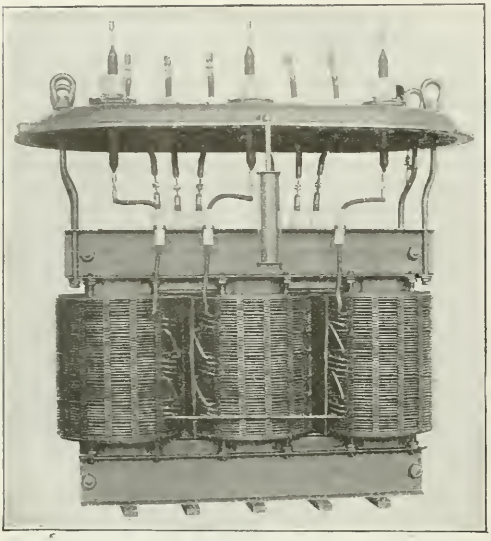


FIG. 6. THREE-PHASE DISK-COIL TYPE TRANSFORMER

like the hairspring of a watch; the winder begins at the inside and winds one insulated turn on top of the other until the desired total width of the coil is reached. Such coils are almost invariably wound circular. The distance between the individual disks is governed by the voltage induced per disk, and should be sufficiently large to secure an effective oil duct. With the exception of transformers for very high voltage, a disk-coil winding is usually arranged interleaved. This means that the total number of necessary disks for the low-voltage and the high-voltage winding is divided in two or more groups, and these are then stacked up alternately. The necessary distances between adjacent disks are maintained by a number of narrow radially arranged spacers. made of good insulating and oil-resisting material.

The excellent results that have been obtained with the distributed-core design made it desirable to combine this type of core with the advantageous disk-coil winding for transformers of moderate capacities. This led to the design shown in Fig. 8.

Transformers for very high voltages are usually wound as cylinder-disk type. This means that the low-voltage winding is made of one or more cylindrical, edgewise-wound barrel coils and is placed next to the core. The high-voltage winding consists of a stack of disks arranged concentrically on the outside. For small currents disk coils are wound with round wire, several turns high per layer per disk; for large capacities copper strip is used.

An extreme case is encountered in transformers of very high current and relatively low voltage, Fig. 7, such as now used frequently for welding purposes or in furnace work. The current of the low voltage amounts, in such instances, to many thousand amperes. This requires such a large copper cross-section (several square inches) that a great number of copper strips have to be combined to form the conductors, and are wound simultaneously.

In conclusion, a few words should be said concerning mechanical stresses in transformers. It is a little-appreciated fact, among electricians and operating engineers, that in every transformer there are set up considerable mechanical forces during its normal operation. In times of overloads, and especially so during short-circuits, these forces are sometimes tremendous, amounting to many tons. They are caused by the repelling action between primary and secondary windings and by the tendency of the turns to embrace as much of the magnetic flux as possible. For a given transformer winding these forces can be calculated for any load or for a dead short-circuit. It is under such electrical stress that the circular-coil design shows its full superiority to any rectangular winding, as the latter tends to distort itself in such a way as to become as nearly circular as its inherent mechanical strength permits. In late years transformer design tends toward short-circuit-proof machines; that is, their electric characteristics are so chosen as to limit the mechanical forces during a short-circuit to such a safe amount as can be withstood by the coil-clamping device. For every transformer the forces developed during momentary overload and short-circuit should be calculated in order to provide for a safe coil-clamping structure. This consists usually of steel plates and structural steel, shown in Figs. 5, 6 and 7. The difficulty of satisfactorily designing such a clamping device lies in its dual purpose to withstand strong mechanical forces and being, at the same time, safely insulated for even the highest voltages.

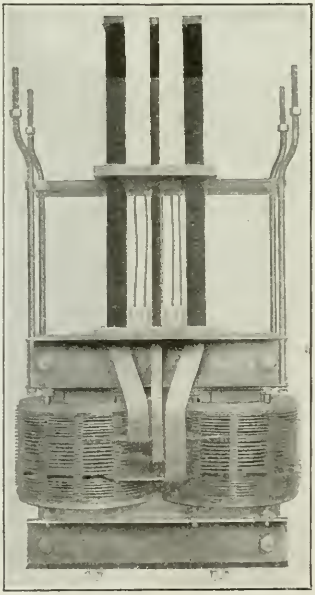


FIG. 7. LOW-VOLTAGE DISK-COIL TYPE TRANSFORMER

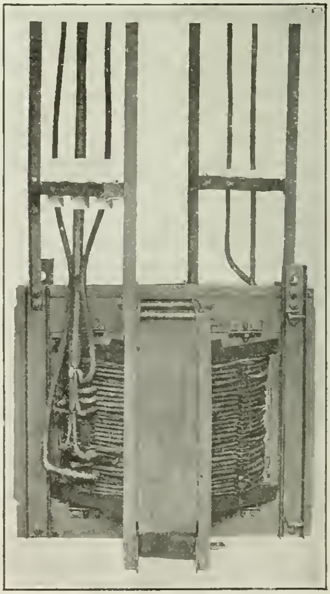
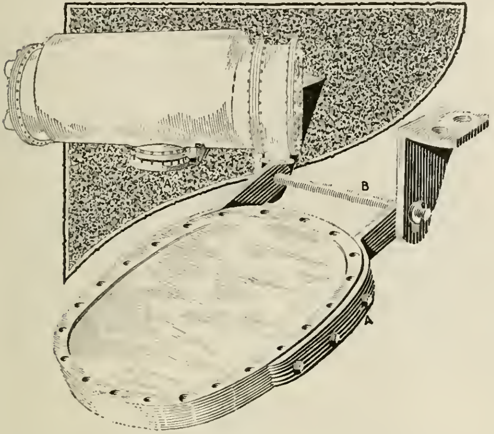


FIG. 8. DISTRIBUTED-CORE DISK-COIL TYPE TRANSFORMER

Rig for Removing a Condenser Plate

In a certain plant the surface condenser is fitted with a heavy removable cover plate at the bottom of the shell. Originally, the plate was held in place by studbolts, and when it was necessary to remove it the services of two men were required, one to hold the plate in position while the last two nuts were removed.

In order to make removal easier and also to reduce the number of men required to do the job, two ¼ x ½-in. iron straps *A*, to act as hinges, were bolted to the cover plate as shown in the illustration. The other end of each was drilled for a ½-in. rod *B*.



HINGED CONDENSER PLATE

Bolted to the body of the condenser shell is a pair of angle irons spaced 8 in. on the inside. Each is made with an oblong hole, the object being to allow the plate to drop at the hinge end sufficiently to permit the plate to take a level position before the stud enters or leaves the holes in the plate. It is readily seen that with the aid of the hinges one man can easily remove and replace the plate, which hangs from the condenser while work is being done and is therefore ready to be replaced when desired.

The Refrigerated Purge Tank

By H. J. Macintire

Every engineer knows that from time to time it is necessary to purge the condenser to remove the inert gases from the system. Those inert gases may be air or decomposed ammonia, and their effect is to increase the head pressure. For instance, if the condenser pressure is 180 lb. and the condensed ammonia is at a temperature of 70 deg. F. (corresponding to a pressure of 114.5 lb. gage) then the difference, 65½ lb., is the extra amount against which the compressor has to work and which is a needless waste of energy.

The usual manner of purging is simply to open a valve at the top of the condenser and allow the gases to pass into a pail of water. Careful engineers make a point of stopping the compressor and keeping the cooling water on the condenser from half an hour to several hours before purging, the idea being that all the ammonia will be condensed and only the inert gases will remain. This is an improvement on the first method, yet it is becoming better known every day that a large amount of ammonia is lost through the purge valve.

This loss of ammonia is due to the fact that the law of partial pressures and the law of diffusion hold for ammonia as for a mixture of perfect gases. This means that the only advantage of running water on the condenser and stopping the compressor is to cool the mixture of gases and condense out *some* of the ammonia. We all know how it is that in cooling atmospheric air we first reach the dew point (where the air is 100 per cent. humid) and then any further cooling will cause precipitation of moisture. One way of *drying* air is to cool it, as is done in the low-pressure can agitation system using stationary air pipes. So, in the condenser, by cooling the mixture of the gases some ammonia is condensed and the remainder is weaker in ammonia content. But at no time will there be a stratum formed with air and inert gases on top and ammonia gas on the bottom. The mixture will be about the same in all parts of the condenser. Therefore, when any purging is done, ammonia as well as air is purged. But can any improvement be made?

In the small-capacity plant it is not worth while to do much of anything more, but the large plants should try to prevent this loss. It is not possible, by means of the condensing water, to cool sufficiently the gases being purged, but they can be refrigerated by means of a cooling coil in an extra header at the top of the condensers into which all of the stands are connected. In purging off, the procedure would be, as before, to stop the compressor and continue the cooling water over the condenser for some time, then open the expansion valve on the freezing coils in the purge header. The gas should be cooled to about 32 deg. F. or lower The gain to be expected may be seen by the following example, with a few assumptions.

Assume a condenser that has 1000 cu.ft. of gas volume, cooling water is at 70 deg. F., and half of the condenser volume is purged. (These conditions are rather extreme, however.) The condenser pressure is taken as 180 lb. as before. As the pressure in a mixture of gases is proportioned to the volumes present, we may say that the gas in the drum is composed of $\frac{65\frac{1}{2} + 14.7}{180 + 14.7} = \frac{80.2}{194.7} = 41.2$ per cent. of inerts and $100 - 41.2 = 58.8$ per cent. of ammonia. Suppose we cooled the gas in the drum to 32 deg. F. The condenser pressure will remain practically the same, but the percentage of the mixture will change, as at 32 deg. F. the vapor pressure of ammonia is 61.9 lb. abs. Therefore, $\frac{61.9}{194.7} = 31.8$ per cent. = relative volume of ammonia present, and $100 - 31.8 = 68.2$ per cent. = relative volume of inerts.

In the first case 58.8 per cent. of 500 cu.ft. = 294 cu.ft., or $\frac{294}{2.3} = 128$ lb. of ammonia purged; in the second case 31.8 per cent. of 500 = 159 cu.ft., or $\frac{159}{4.82} = 33$ lb. of ammonia purged. The difference, $128 - 33 =$ approximately 95 lb. ammonia saved. At 30c. per lb. the gross saving is $28.50.

Advantage of Compression in Internal Combustion Engines

By J. S. A. JOHNSON*

The ideal efficiency of any heat-engine cycle is equal to the difference between the heat absorbed by the working medium and the heat rejected from the working medium divided by the heat absorbed.

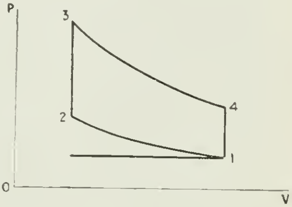


FIG. 1. DIAGRAM OF OTTO CYCLE

The common, or Otto, cycle is represented in Fig. 1, the compression and expansion strokes 1-2 and 3-4 being adiabatics while 2-3 and 4-1 are paths of constant volume. The heat absorbed along 2-3 is $c\ (T_3 - T_2)$, while that rejected along 4-1 is $c(T_4 - T_1)$, the efficiency therefore is

$$E = \frac{c(T_3 - T_2) - c(T_4 - T_1)}{c(T_3 - T_2)} = 1 - \frac{T_4 - T_1}{T_3 - T_2} \qquad (1)$$

in which c is the specific heat of the working medium at constant volume and T_1, T_2, etc., are the absolute temperatures at 1, 2, etc. But

$\frac{T_3}{T_2} = \frac{T_4}{T_1}$ and so $\frac{T_3 - T_2}{T_2} = \frac{T_4 - T_1}{T_1}$, or $\frac{T_4 - T_1}{T_3 - T_2} = \frac{T_1}{T_2}$.

Substituting in equation (1), the expression for the efficiency E becomes

$$E = 1 - \frac{T_1}{T_2} \qquad (2)$$

Since 1-2 is an adiabatic whose equation is $p_1v_1^y = p_2v_2^y$, by combining this with the characteristic equation of a gas, $\frac{p_1v_1}{T_1} = \frac{p_2v_2}{T_2}$, it follows that $\frac{T_1}{T_2} = \left(\frac{P_1}{P_2}\right)^{\frac{y-1}{y}}$ and this substituted in equation (2) gives

$$E = 1 - \left(\frac{p_1}{p_2}\right)^{\frac{y-1}{y}} \qquad (3)$$

from which it will be seen that the higher the compression pressure p_2 for a fixed suction pressure p_1 the smaller will be the value of $\left(\frac{p_1}{p_2}\right)^{\frac{y-1}{y}}$, or $\frac{T_1}{T_2}$, and consequently the greater the value of E.

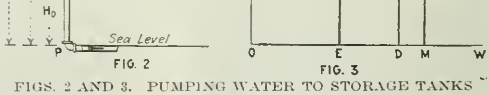
As the term compression conveys the idea of work done on the gas, it is often supposed that this work is lost. A moment's thought, however, will reveal the fact that even though no heat is supplied at the end of compression—no ignition of the fuel charge—reexpansion will occur during which the work that was previously done in compressing will be given back. In practice there will be loss due to leakage, friction and conduction of heat, but ideally, no resultant work is lost due to compression, to whatever extent it may be carried, when the period covers a whole cycle. Whether the actual cycle is of the two-stroke or the four-stroke type, it may be assumed that a constant amount of the working fluid is contained in the cylinder, and that the conditions are such that heat is supplied at constant volume along the path 2-3, and extracted at constant volume along the path 4-1.

An analogy may be of assistance in grasping the conditions resulting from compression. In Fig. 2, T_1 and T_2 are two storage tanks for supplying water to the pipe P. Should water be forced into the pipe from the level of the tailrace V to the height of the tank T_1, and then be lowered again to the tailrace level, no resultant work will be done, and this will correspond with the case of compressing the charge of a gas engine without ignition.

Now let us suppose that when the level S of tank T_1 is reached, a definite amount of potential energy in the form of water is delivered to the pipe P, the weight of water so admitted being represented in Fig. 3 by the horizontal distance FJ, the height above sea level being H_1, so that the energy supplied will be represented by the area $EFJM$. Should this water be discharged at the level V, the useful work done will be $FJRL$ and the energy lost $ELRM$, while the efficiency of the working water will be

$$E_1 = \frac{FJRL}{EFJM} = \frac{FL}{FE} = \frac{H_1 - H_0}{H_1} \qquad (4)$$

Again, let it be assumed that the level of the cushion water reaches the tank T_2 and that the same amount of energy as before is admitted to the pipe, measured above sea-level. The area $BCDE$, Fig. 3, will represent this energy and be equal to the former area $FJME$. Since the altitude at which the working water is received is greater than before, a smaller quantity will be used for the same amount of energy, and accordingly there will be less energy thrown away at the tailrace level. The efficiency in this case will be



FIGS. 2 AND 3. PUMPING WATER TO STORAGE TANKS AND DIAGRAM OF WORK DONE

$$E_2 = \frac{BCNL}{BCDE} = \frac{H_2 - H_0}{H_2} \qquad (5)$$

If H_0, H_1 and H_2 are respectively 200, 300 and 400 ft., the two efficiencies would be $E_1 = \frac{300 - 200}{300} = 33\frac{1}{3}$ per cent. and $E_2 = \frac{400 - 200}{400} = 50$ per cent.

The object of compressing the charge in a gas engine before ignition, or before supplying heat, is to reach as high a temperature level as possible, since in all cases in practice increase of temperature accompanies compression. There would, consequently, be little advantage in compressing isothermally, or below the isothermal—giving a lower temperature at the end than at the beginning of compression—however great the resulting compression pressure might be. Figs. 4 and 5 are useful in illustrating these heat relations. To whatever extent compression may be carried, it is assumed that a fixed amount of fuel with the oxygen supply necessary for complete combustion is present, so that when ignition takes place a definite amount of heat will be supplied. The two cycles, low and high compression, are shown on the *PV* diagram in Fig. 4.

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In the analogy between mechanical energy and heat, head or height corresponds with temperature, while weight corresponds with heat-weight or entropy. Fig. 5 is therefore constructed with these coördinates, and any area on this diagram will represent heat units. The point *A* is at the temperature level of the charge at the beginning of compression, and the substance is compressed adiabatically to *B*. Should no ignition take place at *B*, the line *BA* will be retraced and no resultant work will be done and no heat lost. Normally, the charge is fired at *B*, the heat then being supplied at constant volume, the temperature rising to the level *C* along the path *BC*. The heat admitted will be represented by the area *BCRM*, *M* and *R* being at the sea level of heat or *absolute zero* of temperature. Should compression be carried to *E* before ignition and the same amount of heat be admitted, *EFSM* will be the corresponding area and must be equal to the former area *BCRM*.

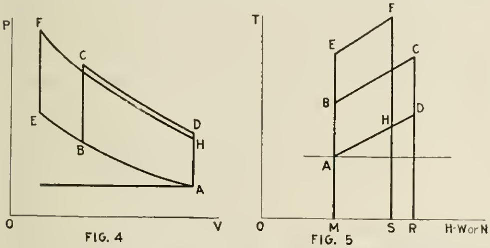


FIG. 4 FIG. 5

FIGS. 4 AND 5. DIAGRAMS OF WORK AND HEAT RELATIONS

For the low-compression cycle, heat will be rejected from *D* to *A* at constant volume, the heat thus rejected being equal to the area *DAMR* and the heat transformed into work in the cycle being *BCDA*. With the high-compression cycle the heat rejected will be *HAMS*, while the work done is *EFHA*. Since the two areas *BCRM* and *EFSM* are equal and the heat rejected for the high-compression cycle is less than that for the low-compression by the area *HDRS*, the work *EFHA* of the high will be greater than *BCDA* of the low by the same amount, and the efficiency of the high-compression cycle will accordingly be greater than that of the low-compression cycle.

The efficiencies will be: for the low,

$$E_L = \frac{BCRM - DAMR}{BCRM} \tag{6}$$

and for the high,

$$E_H = \frac{EFSM - HAMS}{EFSM} = \frac{BCRM - HAMS}{BCRM} \tag{7}$$

Consequently, since *HAMS* is less than *DAMR*, E_H will be greater than E and the advantage of high compression is accordingly evident.

Should the compression be isothermal a slight advantage would even then result with high compression, as shown on the diagram, Fig. 6.

For low isothermal compression, the heat supplied is *BCRM′* and that rejected is *DABM′R;* while for the higher isothermal compression, the heat supplied will be *EFSM″*, an area equal and similar in every respect to the area *BCRM′*, but the heat rejected is less than that for the low compression, being in this case *HAEM″S*.

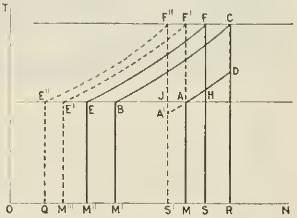


FIG. 6. SHOWING ADVANTAGE OF HIGH ISOTHERMAL COMPRESSION

If the isothermal compression is carried to a point *E′*, so that supplying heat at constant volume will produce the highest temperature at *F′*, a point vertically over the starting point *A*, the efficiency would be a maximum and the work diagram would be triangular, the three cases being represented in the *PV* diagram in Fig. 7.

It should be understood, however, that the conclusion drawn from equation (3), the expression for the efficiency in terms of compression pressure, to the effect that efficiency increases with compression pressure, is correct only for cycles in which the compression and expansion curves are isodiabatics—having the same numerical value for the exponent *n* in the equation PV^n = Constant—notwithstanding the fact that high compression is advantageous even though these two curves are not similar in the respect mentioned. For isothermal *compression* and, for example adiabatic *expansion*, there would be no advantage, but a distinct loss, in carrying the compression higher than *E′*, Figs. 6 and 7, resulting in a pressure at the end of expansion corresponding to the point *A′*, Fig. 7, less than the suction pressure *A* and giving a negative loop *A′AJ* on the heat diagram, as is shown in Fig. 6.

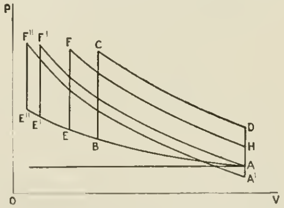
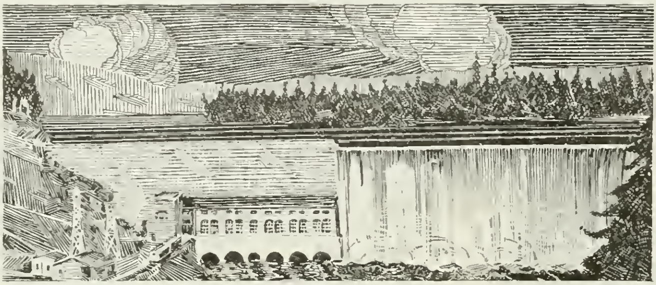


FIG. 7. SHOWING COMPRESSION FOR MAXIMUM EFFICIENCY

The injection of water with some fuels is supposed to prevent "cracking" and preignition by a reduction of the compression temperature. Although the primary object of compression is to raise the temperature level, the efficiency will increase with compression pressure even though there be no corresponding rise in temperature, and the advantage of high compression and water injection over low compression without water, but with the same final compression temperature, is evident.

Furthermore, the adiabatic expansion for steam is represented by a curve that is somewhat flatter than that for air or gas, and the expansion curve with water injection would accordingly be raised, giving a larger indicator card.



POP'S WATER-POWER COURSE

By

John S. Carpenter

AFTER Jimmy had finished his lunch of coffee and fried holes, alias doughnuts, he beat it back to the plant as fast as an aching corn would let him. There he found Pop waiting for him to begin the talkfest.

"Come on in, Jimmy," exclaimed Pop; "we'll make it two-handed! I jes' been figgerin' out a draft tube and scroll case fer fun."

Jimmy gazed in doubt at the wiggly thing, shown in Fig. 1, that Pop called a scroll case. "How drunk d'ye have to be to see things like that, Pop?"

"Draw up that chair," bellowed Pop with impatience, "and git out a pencil and paper! Let's say that our imaginary plant carries 200 cu.ft. per sec. to each turbine. Now we'll say that the head is 50 ft., which means that the turbines has about 100 hp. each at 88 per cent. efficiency. Good practice says that the water velocity at the inlet of the case should be about 15 to 20 per cent. of the spoutin' velocity, the lower the better, of course, so fur as friction is concerned. Now that means find the square root of 50, which is a oozlum more than 7, multiply that by 8, and take 15 per cent. of the answer." Pop ditched his chew and got busy with the pencil. "Jes' 8.4 ft. per second."

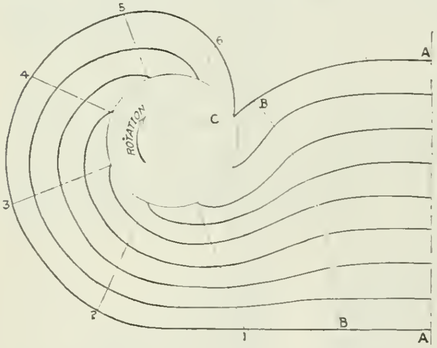


FIG. 1. PLAN VIEW OF SCROLL CASE

"Well, Pop, 200 cu.ft. per sec. divided by 8.4 ft. velocity gives us 23.8 sq.ft. area at the line *AA*."

"Yep, that's right. Now then, the water speeds up a bit in goin' to the line *BB*, jes' before some of it goes into the turbine. So from the point *C* to section 1 we figger that one-fourth of the whole amount has gone into the turbine because that distance around the turbine case is one-fourth of the whole circumference."

"I check you on that, Pop." A moment's thought occupied the two, after which Jimmy blurted out, "I guess, then, that section 1 should be just large enough to pass three-fourths of the full quantity, or 150 cu.ft., and between sections 1 and 2 we drop 25 cu.ft. more because that part is one-eighth of the circumference of the case. Therefore section 2 handles 125 cu.ft. per second."

"Great, Jimmy," beamed Pop; "you show signs of intelligence at times! Now then, jes' as you says, section 3 takes 100 cu.ft., 4 takes 75, 5 takes 50, and 6 takes 25. At the point *C*, theoretically there's none."

"Now our friend the lecturer," spoke up Jimmy thoughtfully, "he said that some engineers keep the velocity the same all the way down to section 6." Jimmy saw a great light mentally and was about to spring it, but Pop utterly squelched it.

"But before you can figger the width or height of any of the sections, we must first know what kind of shape we gonna make it. Them cases is sometimes made circular in cross-section and then they's also made rectang'lar. Mos' cases they's rectang'lar. Now we'll say that our case is 3 ft. high at section 1, and that the height drops 3 in. at each section line."

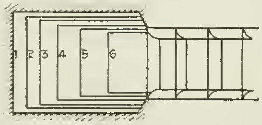


FIG. 2. SECTIONS OF SCROLL CASE

"That makes it darn complicated, Pop. Why do that?"

"It makes the sections, say from 4 down to 6, too darn high comparin' 'em to their width. The best way is to keep 'em as near square as you kin." Pop drew in the sections for each line from 1 to 6, as shown in Fig. 2. "Now then as we wuz told, some engineers makes them velocities decrease all the way from section 1 to 6, and they usually make the water at 6 run about 20 per cent. less speed than at 1. The idee is to make the friction about the same for all them slices of water, seein' that the water has to travel pretty far down to section 6. Now I skitched in the flow lines showin' about how the water is s'posed to go."

"Pop, don't forget that the lecturer said that the water does not flow quite so regular and smooth as you show it. There are big differences in velocities across a section, the water at the outside traveling slow, while as it moves in toward the turbine case it speeds up very fast."

"Ye-es," drawled Pop, "but that's got nothin' on what happens in the inside of a draft tube at most any load, and which we'll dooly consider in a little bit."

"Yes, but why is it that they go to the expense of making a fancy scroll case when it seems that a square or a·round hickey would do just as good?"

Pop adjusted his pinchers again, this time farther toward the end of that nose of generous length. "They claims that in the scroll case, when it's made accordin' to Hoyle, the water flows jes' as it natcherly wants to. In a square box, like in Fig. 3, there's dead water at points *A* and *B* and this jes' turns around like a whirlpool and makes extry friction. Now, in the case of a bastard scroll made by an offset circle, like in Fig. 4, the highbrow guys says that the water doesn't travel uniform and that the water is allus seesawin' back and forth through that narrer cranny. But, if they make the circle big enough, it won't be so bad, 'cause then the velocities is low and you know that friction varies as the square of the velocities."

"I feel satisfied that the scroll case is the real cheese, then; so now as you say, let's dooly take up the draft tube and tear it apart. First of all, just to start something, tell us in plain everyday lingo why the critter is and what right it has to existence."

"I git cher. The draft tube is a—is a—is a piece of pipe that goes in between the turbine and the tail water and does what it says, making more draft by slowin' down the water as much as possible. It may be long or short, straight or crooked, round or square, besides a lot of other shapes that would make a good boilermaker go on a drunk to try and cut out the plates fer sich a geegaw; but after all, the main thing is to slow up the water gradual-like, not too fast."

"It's as clear as mud to me now, Pop. Make some sketches and show us what you're beefing about."

Pop took another chew and then got the stubby pencil going.

"Well, the upper part of the draft tube takes the water right from the runner and at a high velocity; from there on down the area of the draft tube gits bigger and so makes the water slow down, changin' kinetic energy back to potential energy. Potential energy is the kind of energy that a body may have 'cause it's high up in the air and in fallin' is capable of doin' work; while kinetic energy is the kind it has because it's in motion and kin do work by bein' stopped or slowed down. The great fact for you to git clear is that the sum of the potential energy and the kinetic energy is always equal to the total energy of the body, whether it's water or booze.

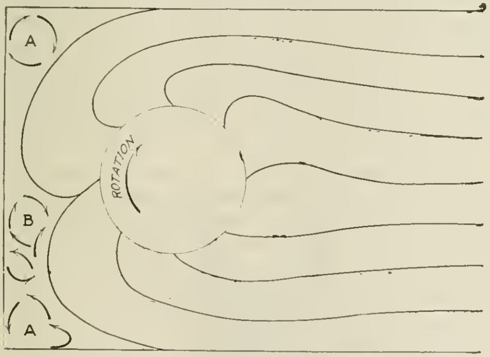


FIG. 3. EFFECT OF SQUARE BOX

"Don't get you a-tall, Pop. Explain it better."

"Son, you git your pay in bills and coin. You kin always change one into the other, such as bills into coin and then back to bills again; but the sum total always remains the same—it's always so much money. So it is with energy. Git me?"

"Unless you spend some of it," suggested Jimmy cautiously.

"Somebody's allus takin' the joy outa life—now it's you! Now, look at this here Fig. 5. Here is an example of a straight draft tube made of steel plate. It has a taper of 4 in. per ft., which is a whole lot, and that can only be used on very short draft tubes. I sketched out the velocity curve alongside. Now," said Pop, shoving Fig. 6 under Jimmy's eyes, "this is a concrete draft tube, and of all the pot-bellied things agoin' they kin do more deviltry in designin' these critters than you thinks. That one up at the plant is a peach. The designer wuz up thar and I ast him how many he had before he made that sprawlin' pipe. He looked at me kinder funny-like and I s'pose took pity on me. Then he says that on account of puttin' the units close together and in groups of two, they bent the draft tubes to fit. The construction foreman told me that as fast as he hired form-carpenters and showed 'em the drawin's they throws up and blows the job."

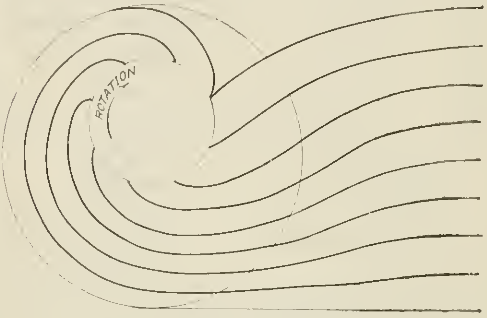


FIG. 4. BASTARD SCROLL CASE

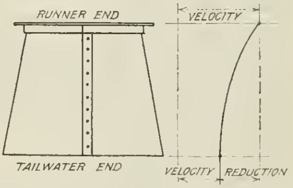


FIG. 5. STRAIGHT DRAFT TUBE AND VELOCITY CURVE

"Why in thunder do they give the bottom such a kick in the slats and flatten it out so?" said Jimmy, somewhat scornfully. "Seems like they made it uselessly complicated."

"They does that to save goin' down so deep with their foundations, and that saves concrete, too, see? Our friend the lecturer says he don't agree with some o' them fellers that makes the bottom end too flat. As we'll see later, at most all loads except that at which the runner works best, the water runs down through the draft tube with a sort of spiral action, like the thread on a bolt, and the flattenin' breaks up that turnin' motion, makin' more resistance to the flow."

"Now tell us what the permissible velocity through the bottom end of the draft tube is. Mind that highbrow word 'permissible,' Pop."

"The lecturer said they usually uses 10 per cent. of the spoutin' velocity and which is none too low, either. Now, on our 50-ft. head plant we wuz makin' the scroll case fer, that would be 5.6 ft. velocity."

"And Pop, just the same as with the scroll case, the lower the velocity the better until the areas get too big by making the velocities too low."

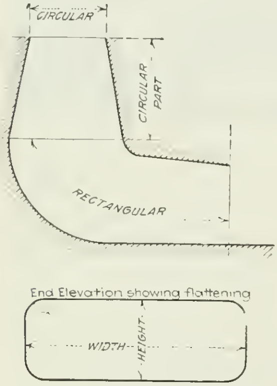


FIG. 6. CONCRETE DRAFT TUBE

"Yep, that's right. Jes' to make it complete, I sketched out the whole thing, here in Fig. 7."

"S'posin', Pop, they made the taper of the draft tube too great, what would happen?"

"I saw the lecturer off at Casey's Grill, and he gave me a whole earful on that. He told me about a big 4000-hp. turbine runnin' under 425 ft. head, speed 600 r.p.m.; some whopper of a machine. Well, after they got the thing finally set up in the plant and turned on the water, she spluttered a bit, and then got down to business, but she shook as if she'd have a conniption any minute, and she got worse as soon as they tried to put anything like full load on 'er. The big guys came in and give 'er the wunst over and told 'em to shut 'er down till they sends a man inside.

"The man came in, but he couldn't find anything incriminatin', so they tore her insides out and went over 'em with a fine-tooth comb. But that didn't help. Then they calls a council of war and trots in the royal family with the crown jools on and decides to brace her wherever they kin hang a few I-beams and tie rods. That helped some, 'cause then they had 'er tied down to solid rock; but the old rock gits a-shiverin', too. 'Bout then a broken-down college perfesser arrives on the scene and tells 'em where they spilled the beans. They plastered the inside of the draft tube so that the taper wuz right and the shakin' before usin' lays off."

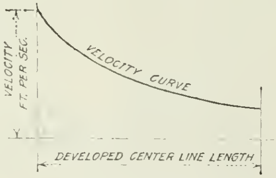


FIG. 7. VELOCITY CURVE IN CONCRETE TUBE

"Say," snickered Jimmy, "did the professor marry the boss's only daughter and then struggle along on a mere trifle of $5000 a year?"

"Dunno," growled Pop; "they probably gave him the price of a haircut and one-seventy-five a day while he kept sober."

Pop got up and stalked off into the boiler room. Suddenly he poked his head around the doorway and yelled, "Say, Jimmy, next time we study the turbine itself!"

Rules for Visitors in the Power Plant

By H. T. Moore

1. Upon entering the engine room, walk nonchalantly toward the nearest generating unit, scrape your feet on the guard railing, shake cigar ashes on the revolving commutator and spit in the direction of the switchboard. This careless attitude toward machinery will impress the engineer and reduce the likelihood of your being thrown out.

2. Ignore the engineer if he tries to engage you in conversation. He is a mind reader and a criminologist and will identify your name and business by your physiognomy and fingerprints. It is well to keep him guessing, especially if you object to his getting your number.

3. Wander around promiscuously, rubbing your hands on the polished parts and tracking coal dust in from the boiler room. The engineer is fond of housecleaning, and as a liberal stock of polish, lye, soap, water and mops is always on hand, he will enjoy scrubbing the floor after you leave.

4. It is always interesting to know whether the bright work, brass fixtures or bare pipes are smooth, rough, hot or cold. Handle everything in sight and urge others to do likewise if in doubt as to the physical characteristics.

5. If the governor pounds when the load changes, call the engineer's attention to the noise and tell him how to correct it. He is usually hard of hearing and wouldn't suspect it if you didn't tell him. He also appreciates free advice and may be willing to shut down the engine and make the needed repairs while you wait.

6. As the engine room is a lonesome place, stay around as long as you please, come often and bring your friends. The engineer is always glad to entertain visitors as he has nothing else to do but swear at the fireman and run a lunchpail cafeteria.

7. If you find the engineer removing the short from a short-circuit or removing a prime mover that is no longer in its prime, be sure to spring on him the funny story you heard at the pile drivers' convention. Stand in close proximity to his working zone and continue the mirth-provoking monologue until the external pressure against the seat of your trousers and your sudden departure through the nearest exit convince you that the interview has been terminated.

8. After inspecting the boiler gage-glasses, order the fireman to open the furnace doors to assist you in estimating the color of the smoke escaping up the chimney. Point out the air holes, leaky tubes and the impossible grade of fuel he is burning. These helpful hints may make him firing mad, but will temporarily increase his firing efficiency. The management appreciates humane suggestions affecting the morale of the boiler room, preferring to furnish pure carbon nuggets rather than have the coal heavers overworked or uncomfortable.

9. The danger signs in the high-tension room (or electrocution zone) are intended for ordinary workmen and wops and need not be taken seriously by civilians with insurance or bored persons looking for new sensations. Visitors desiring to poke canes or umbrellas at the high-voltage busbars to observe the corona effect should, however, write on their visiting card their choice of cemeteries and also leave their roll with the engineer before conducting any electrical tests. This foresight will save much time and expense.

The Electrical Study Course—Measurement of Alternating Current and Voltage

It is first shown that it is impossible to use direct-current instruments on alternating current, and then various types of alternating-current instruments are described. This is followed by an investigation of average and effective values of alternating currents and voltages.

IN ORDER to measure alternating currents and voltages, ammeters and voltmeters are used as in the case of direct currents and voltages, but the construction of the instruments is different. In Fig. 1 is illustrated the usual type of direct-current instrument. In it the pointer *a* is attached to the coil *b*, which is suspended between the poles *cc* of the permanent magnet *d*. When current passes through the coil *b*, it is caused to turn because it is in the magnetic field between the poles *cc*. Its motion is opposed by spiral springs *e*, whose tension is adjusted so that the distance through which the coil moves is proportional to the current through it. Such an arrangement would not serve to measure an alternating voltage or current, because the current passing through the coil *b* would be constantly reversing its direction, and consequently the coil would tend to swing back and forward in unison with the current. As a matter of fact there would be no motion of the coil at all, because the changes in current are so rapid that the coil cannot follow them; before it begins to move in one direction, the current through it has reversed and tries to move it in the opposite direction.

The objections to the direct-current type of instrument are overcome in one form of alternating-current instrument by the use of two coils instead of a single coil and a magnet. A voltmeter of this type is illustrated in Fig. 2. The coil *b* is similar to the one in the direct-current instrument, but in place of the magnet the stationary coils *ff* are used. These are connected together at *g* and are in series with the resistance *R* and the coil *b* across the line, which is connected to the terminals *TT*. The coils *ff* are in effect an electromagnet, the magnetic field of which reverses for each alternation of the current through them. The coil *b* is situated in this field, and the current through it reverses in unison with the field. Consequently, the force acting to rotate the coil is always in one direction and will cause it to move through a greater or less distance depending upon the magnitude of the current.

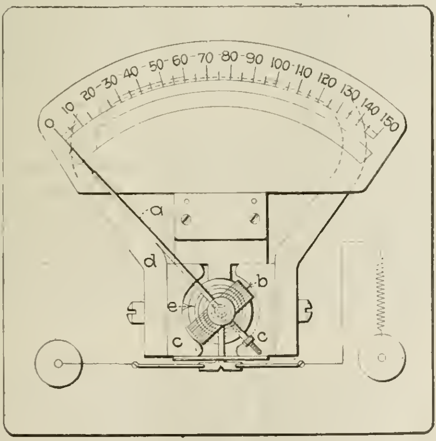


FIG. 1. INTERIOR CONSTRUCTION OF A DIRECT-CURRENT VOLTMETER

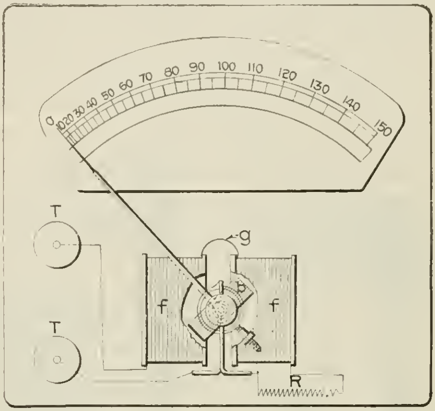


FIG. 2. INTERIOR VIEW OF THE CONSTRUCTION OF A TWO-COIL TYPE ALTERNATING-CURRENT VOLTMETER

Another type of alternating-current instrument is the ammeter illustrated in Fig. 3, known as the inclined-coil type. A soft-iron vane *b* is mounted on a shaft, which is perpendicular to the base of the instrument. Vane *b* is mounted on the shaft at about a 45-deg. angle, and the coil *a* inclines at a 45-deg. angle with the base. When current flows through the coil *a*, a reversing magnetic field is set up by it. The vane *b* tries to turn into a position parallel to the field and in so doing causes the spindle and attached pointer to move. The amount of motion is controlled by a spiral spring.

In spite of the fact that the current which actuates them is constantly reversing, alternating-current instruments give constant deflections. The question then arises, What value does an alternating-current ammeter or voltmeter really indicate? At first sight the answer would appear to be, The average value of the instantaneous values. Thus, if the curve in Fig. 4 represent a voltage whose maximum value is 100 volts, the average of the instantaneous values for each half-cycle would be $0 + 50 + 86.6 + 100 + 86.6 + 50$ divided by the number of values added together, namely, 6. Hence we have, average value of voltage $= \frac{373.2}{6} = 62.2$ volts. Owing to the fact that only a few values have been taken, this value is not strictly correct. The exact value is 63.7 volts. However, this average value is not the value that would be recorded by an alternating-current voltmeter, and as a matter of fact it is of no importance in alternating-current practice and will therefore receive no further attention.

The value recorded by alternating-current instruments, and the one that is of supreme importance, is known as the *effective* value of current or voltage. An explanation of what this value is, is given in what follows:

In Fig. 5 is shown a direct-current generator G connected to a resistance R. Suppose the voltage E to be 200 volts and R to be 20 ohms. The current will then be, $I = \frac{E}{R} = \frac{200}{20} = 10$ amperes. The power used up in R is, $W = EI = 200 \times 10 = 2000$ watts. Since $E = IR$ we can also say that $W = IRI = I^2R = (10)^2 \times 20 = 2000$ watts. Or, since $I = \frac{E}{R}$, we could write, $W = E \times \frac{E}{R} = \frac{E^2}{R} = \frac{(200)^2}{20} = 2000$ watts. In other words, we have the choice of three ways of finding W. That is, $W = EI$, or $W = I^2R$, or $W = \frac{E^2}{R}$.

Suppose now that in Fig. 6 we have an alternator G connected to a resistance R of 10 ohms, and assume that the maximum value of the voltage of G is 100 volts, corresponding to the curve in Fig. 4. The power imparted to R will have a constantly changing value. When the voltage is zero we have $W = 0$; when it is 50 volts $W = \frac{E^2}{R} = \frac{(50)^2}{10} = 250$ watts; when it is 86.6 volts $W = \frac{(86.6)^2}{10} = 750$ watts; and when it is 100 volts $W = \frac{(100)^2}{10} = 1000$ watts. The average value of W for a half-cycle is therefore $\frac{0 + 250 + 750 + 1000 + 750 + 250}{6} = 500$ watts. Consequently, we have $\frac{E^2}{R} = 500$, where E^2 is the average value of the squares of 50, 86.6, etc., in Fig. 4. Since R is 10 ohms, we have, $\frac{E^2}{10} = 500$, or $E^2 = 5000$, from which we get, $E = \sqrt{5000} = 70.7$ volts. This is the effective value of the voltage; *it is the square root of the average of the squares.*

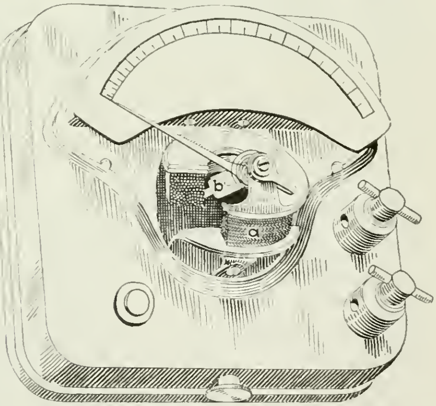


FIG. 3. INTERIOR CONSTRUCTION OF AN INCLINED-COIL TYPE ALTERNATING-CURRENT AMMETER

When the voltage is at a maximum, the current will also be at a maximum, and its value will be equal to $\frac{E}{R}$, or $\frac{100}{10} = 10$ amperes. The curve in Fig. 7 is a representation of it. When the current is zero $W = 0$; when it is 5 amperes $W = I^2R = (5)^2 \times 10 = 250$ watts; when it is 8.66 amperes $W = (8.66)^2 \times 10 = 750$ watts; and when it is 10 amperes $W = (10)^2 \times 10 = 1000$ watts. The average value of W for a half-cycle is therefore $\frac{0 + 250 + 750 + 1000 + 750 + 250}{6} = 500$ watts. It is seen that the I^2R method gives the same result as the $\frac{E^2}{R}$ method, showing that they check each other. From the result we have $I^2R = 500$, where I is the average value of the squares of 5, 8.66, etc., in Fig. 7. Since R is 10 ohms, we have, $I^2 \times 10 = 500$, or $I^2 = 50$, from which we get, $I = \sqrt{50} = 7.07$ amperes. This is the effective value of the current.

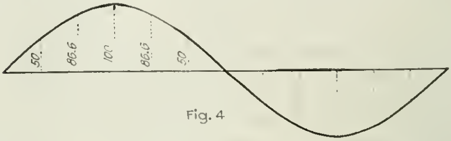


Fig. 4

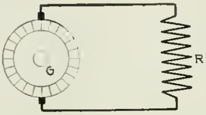


Fig. 5

Fig. 6

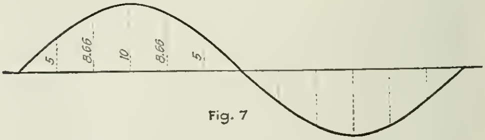


Fig. 7

FIGS. 4 TO 7. SINE CURVES OF VOLTAGE AND CURRENT, AND DIRECT- AND ALTERNATING-CURRENT GENERATORS CONNECTED TO RESISTANCES

If we multiply the effective value of voltage by the effective value of current, we have $W = EI = 70.7 \times 7.07 = 500$ watts, which again gives the same value as that already found and shows that the results are consistent. The effective value of voltage or current is always equal to the maximum value multiplied by 0.707. Thus, in our example we find, Effective voltage $= 100 \times 0.707 = 70.7$ volts, and Effective current $= 10 \times 0.707 = 7.07$ amperes. We therefore have the general rules, *effective volts = maximum volts* × 0.707, and *effective amperes = maximum amperes* × 0.707.

The effective values of current and voltage are the ones that are indicated by ammeters and voltmeters, so that whenever we speak of a current or voltage of a certain value we mean its effective value. For example, when we say that a current is 10 amperes, we should really say that the *effective* current is 10 amperes, but in practice the word effective is omitted; it is always understood that we mean effective if we say nothing to the contrary.

The first problem of the preceding lesson was to find the sum of two voltages differing in phase by 90 deg., one of which is 300 volts and the other 400 volts.

The vector diagram would be as shown in Fig. 8. The length of vector E_1 is made equal to 300 volts and is laid off vertically; the length of E_2 is made equal to 400 volts and is laid off horizontally, thus making the angle between the two vectors equal to 90 deg. The line CD is drawn through the end of E_2 parallel to E_1, and the line AD is drawn through the end of E_1 parallel to E_2, thus forming the parallelogram $ABCD$. The diagonal BD is then drawn, giving us the vector E representing the sum of E_1 and E_2. Since BCD is a right-angle triangle in which the side CD is equal to E_1, we have, $(E)^2 = (E_1)^2 + (E_2)^2 = (300)^2 + (400)^2 = 250,000$, from which we get $E = \sqrt{250,000} = 500$ volts.

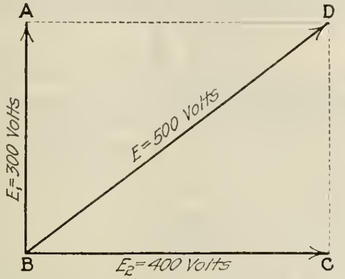


FIG. 8. VECTOR DIAGRAM OF VOLTAGES IN PROBLEM

The second problem was to determine the speed at which a 12-pole alternator must run in order to generate a 50-cycle voltage. We know that frequency is given by the expression $f = \frac{PS}{120}$, and we therefore have, $50 = \frac{12 \times S}{120}$. That is, $50 = \frac{S}{10}$, from which we see that $S = 500$ r.p.m.

If the maximum value of the voltage in Fig. 4 were 311.13 volts, what would be the effective value? What current would flow if such a voltage were connected across a resistance of 4.4 ohms? If an alternating current voltmeter reads 120 volts when connected across an alternating-current source, what would the maximum value of voltage be?

Delegates to the Convention, National Association of Stationary Engineers

Power will again this year try to publish the photos of attending delegates in its convention fun maker, the *Power Pup*. Also each delegate will be given a package of cards bearing his photograph, name, position, association and city. But to do this we must have either your photograph or the electrotype we gave you at previous conventions, together with name, position, association and city.

All photographs must be of post-card size and show only head and shoulders—the three for a quarter kind will do. All photos must reach us by Aug. 20. No photos will be accepted at Huntington, as Huntington affords no facilities for making electrotypes.

Please call this to the attention of your fellow-delegates and mail your photograph or electrotype today. These cards will help you to associate the names with the faces of the many new friends you will make. Address, Editor of *Power*, Tenth Avenue at Thirty-sixth Street, New York City.

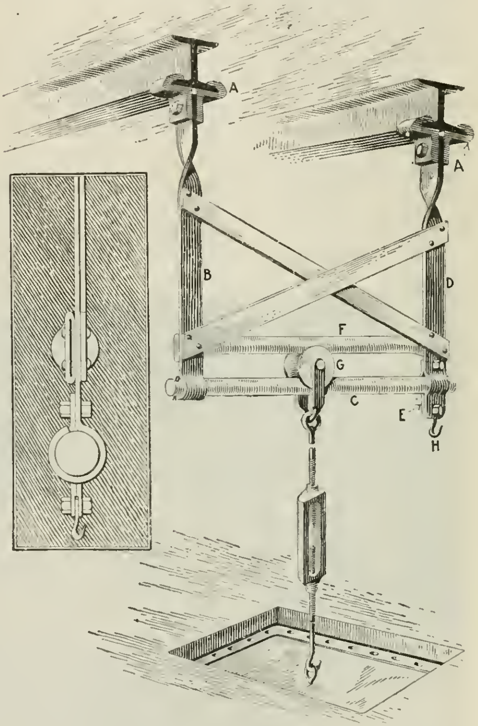
Strainer Cover Lifter

A labor-saving arrangment in the shape of a rig for lifting the cover of a large water-pipe line strainer is shown herewith. By means of this device one man now does the work that formerly required four.

Fortunately, two iron beams ran parallel along the ceiling of the basement. To each of these beams a two-piece clamp *A* was bolted, the clamping bolt also passing through a hole in one end of a piece of flat iron bar *B* and *D*, bent at a right angle so as to facilitate bolting the crossbars in place.

The lower end of the rod *B* is bent to hold a 2-in. rod *C*. The end of the rod *D* is made in the shape of a bearing, the cap *E* being secured in place by bolts. This supports the other end of the 2-in. rod, on which a roller *G* travels. A 2-in. guide rod *F*, the ends of which are flattened, is bolted to the crossbraces.

From a pin passing through the pulley *G* is hung a U-link, to which one end of a turnbuckle rod is hung. Another turnbuckle rod is made with a hook for engaging an eyebolt that is secured to the center of the strainer cover. At one end of the crane a hook *H* is attached, on which the eyebolt is held when not in use.



CRANE FOR LIFTING STRAINER COVER

When the cover is to be lifted from the strainer, the hook of the turnbuckle is hooked into the cover eyebolt, and after removing the cover nuts the turnbuckle is screwed up enough to clear the cover plates from the studbolts. The roller and cover are then pushed to one end of the rail *C* until the cover is wanted for replacement.

Negus-Tiffany Coal Agitator

In the operation of underfeed boiler stokers trouble is frequently caused by the coal hanging up in the hopper. With dry fuel this does not occur, but with wet coal the stoker plunger is pushed through the fuel bed and upon the return stroke the coal fails to fill the cavity left by the plunger. The consequence is that the stoker does not work to capacity, the fuel may be unevenly distributed in the furnace, and air leak holes form. When coal hangs up in the stoker hopper, it is necessary to employ men to poke it down so that the plungers may receive a full charge of fuel.

That this hanging-up trouble of wet fuel can be taken care of by mechanical means may be seen by an examination of the accompanying illustration. This attachment shown is known as the Negus-Tiffany coal agitator and is manufactured by the W. E. Ellis Co., Haverhill, Mass.

This stoker agitator consists of agitating arms, the number depending on the size of the stoker and the number of stoker retorts. These arms are secured to a 1 32-in. shaft supported by suitable bearing supporting bars that reach across the bottom of the hopper. This part of the apparatus is placed at the bottom of the hopper (see Fig. 2), the agitators being spaced so that they come midway between the stoker plungers. The agitators are made of 2 in. wide by ½ in. thick metal, and the yoked ends are 1½ in. wide and ½ in. thick. The end next to the front of the stoker hopper is bent up at an angle of 30 degrees. Attached to the outside of the hopper is a bracket that carries a bell crank, one end of which is connected to the agitator shaft by means of a link connection. The other end is connected by means of a connecting-rod to a crank attached to the stoker ram shaft (see Fig. 1). It will be observed that the rod connection to the bell crank has a two-way motion at the same time. This requires a special design of joint, and it consists of a split bearing hollowed out on the inside so as to house a ball joint, through which a stud passes at right angles with the bell crank. The stud also passes through the end of the connecting-rod attachment, forming a type of universal joint.

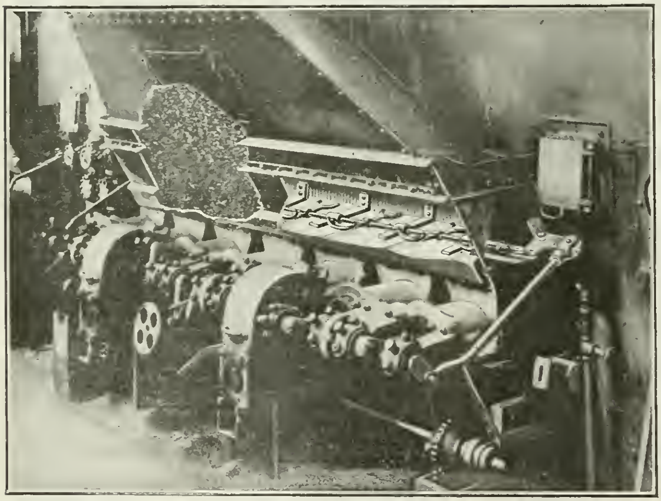


FIG. 1. COAL AGITATOR AS APPLIED TO A STOKER HOPPER

The crank has a throw of 3 in. from the center, which gives a 6-in. movement of the bell crank. As the bell crank makes as many oscillations as the stoker shaft, the agitator arms are moved across the bridge of coal formed by the plungers before the plungers make a second forward movement. This undermines the packed coal, and the plunger box is filled ready for ramming into the furnace. Thus a full charge of fuel is kept in front of the rams at all times.

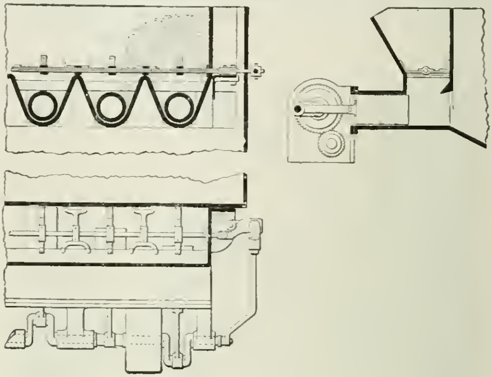


FIG. 2. DETAILS OF THE COAL AGITATOR

In order to determine just what the apparatus would do, a well-known stoker engineer made many tests, even going so far as to turn the hose into the hopper which had been filled with coal and saturate the fuel, then tamping it as hard as possible with a tamping bar. Under this severe condition the device fed the coal without trouble, although the wet fuel nearly put out the fire.

The Minister of Railways has approved the project of the electrification of Belgian railways, and instructions have been issued to have plans submitted for the electrification of the line between Brussels and Antwerp and Brussels-Luxembourg, to be followed immediately with an electric line between Brussels and Ostend. The current will be supplied with overhead wires or the third-rail system, according to the location and circumstances. Work will be commenced at the beginning of 1920, and it is proposed that the journey between Brussels and Antwerp be made in 25 minutes and to run trains every 15 minutes.

Animal fats and grease never should be used on rubber belts. Boiled linseed oil is good; also equal parts of black lead, red lead, French yellow, litharge and enough Japan dryer to make it dry quickly.

EDITORIALS

Byproducts From Coal To Pay for Power

ONE of the greatest developments appearing on the horizon in the power-plant field today is suggested on other pages of this issue in an article on low-temperature distillation of coal, by C. M. Garland. The author points out that work along this line has been in process for the last fifteen years, the primary object being to make of bituminous coal a clean smokeless fuel for domestic and small-power use to replace anthracite, semi-anthracite and hard coke. All the gas generated is required in the coking process, but byproducts in the form of a light tar and ammonium sulphate, ranging in value from $2.50 to $3.50 per ton of coal treated, are recovered. These values make the investment worth while and permit marketing the coke at a favorable price.

In connection with large power work there are attractive possibilities for low-temperature distillation. The opportunity for effecting a saving, however, has not been great enough to encourage the larger investment required, and the initiation of a new enterprise requiring skilled attendance and perhaps some development to meet the specific conditions of the plant and of the fuel used.

As stated by the author of the article, there is greater outlook for a plant utilizing the low-temperature process to recover principally the tars and a byproduct gas producer of the Mond type to recover the ammonium sulphate. The value of the byproducts would be doubled and in like proportion the opportunity to effect a saving in power generation. As the primary product, the gas from the producer could be burned under the boilers as fuel or used directly in internal-combustion engines. It would contain about seventy per cent. of the heat in the original coal, and as it can be burned at higher efficiency under boilers, in the ratio of say, eighty to sixty-five for average everyday operation, its effective value would be about eighty-five per cent. of that of the coal. In other words, there would be only a fifteen per cent. loss over using the coal as fuel direct.

It has been estimated that the value of the byproducts would range from five to six dollars per ton of coal, costing in the first place from two and one-half to four dollars per ton, depending on the location of the plant with respect to the mine. On this basis it is evident that the byproducts would not only pay for the coal, but depending on the size of the installation, there would be a margin sufficient to cover the fixed and operating costs and perhaps provide a slight surplus. In brief, there is the possibility of making a gain of one hundred per cent. or more, simply obtaining the power for nothing.

Such a plan is essentially adapted to constant load, so that it is applicable to plants having a load of this character twenty-four hours per day and preferably the year around. In a large plant the system could be arranged, of course, to cover that portion of the production represented by the minimum load. For a paying investment the author gives as a minimum limit in size a plant burning fifty tons of coal per day of twenty-four hours, or roughly, a two-thousand-kilowatt installation. Such a plant would bring enough returns to pay for the coal. Its initial cost is placed at $150 per kilowatt, being divided into $85 for the power plant and $65 for the byproduct equipment. For a one-hundred ton plant the estimated cost is $125 per kilowatt, divided $65 and $60, respectively, with byproduct values sufficient to pay for the coal and all operating expenses. Doubling the plant capacity again would increase the economy sufficiently to also care for the overhead and possibly provide a surplus.

Such are the possibilities. The maximum gain could not be expected in the first plant, although satisfactory returns would be probable. There is need of pioneer work and development of the combination plant, which, unfortunately, does not lend itself to experiment on a small scale. For this very reason, even with such magnificent returns in sight, private capital may hesitate to venture into the unknown. Research of this character might better be conducted as a Government project, and the logical department would be the Bureau of Mines. Results available to all would be obtained more quickly, and the high reputation and impartiality of the Bureau would insure confidence in the work.

The component parts of the plant outlined have been operated successfully, and there are no insurmountable obstacles to designing a combination plant that would give satisfaction. In its operation it will require chemists and skilled engineers, but this is a day of progress, and being such, we no longer can afford to burn byproducts worth more than the original cost of the coal. A power-plant efficiency of one hundred per cent. would not permit it. Eventually, economics will dictate the distillation of coal to recover the byproducts.

New England Coal Again

ANOTHER attempt is made to work the New England coal mines, this time at West Mansfield, Mass. Newspaper propaganda, full of favorable comments of supposed authorities, says nothing of the vain attempts which have been made to mine and use this graphitic coal except that the mine has been worked "on and off" since 1835. Since only 30,000 tons are claimed to have been mined from the entire section and the capacity of this single mine is given as 200 tons a day, it is apparent that the operation must have been "off" most of the time.

The trouble is that the New England coal is harder than Pharoah's heart. It can be burned, but New Englanders have preferred to import coal that did not need so much urging. A few more coal famines like that of 1917, or the devising of methods for making it take its oxygen more willingly may bring about its utilization; or perhaps it may be found more valuable for some other purposes than for fuel. Large deposits of carbon like these ought to find some use in the industries. Any attempt to exploit the mines, however, and especially to sell stock in them, ought to be made with a frank acknowledgment of the shortcomings of their contents as fuel and of the disastrous outcome of the many previous attempts to operate them. Such newspaper statements as that "Geological experts say that the district is rich with coal and that it can supply the needs of all New England" and that "according to tests the best grade of anthracite coal is to be found in this section," unqualified by such acknowledgments and admissions, throw considerable doubt upon the bona fides of the venture.

Physical Tests of Boiler Steel Plate

DESIGNERS and manufacturers of boilers will be interested in the article by Frederick Biggam, inspector of steam boilers for British Columbia.

It is easy to make rules and draw specifications, but in practice things are not always distinctively one thing or another, and vagaries of the sort described in this article may well puzzle the inspector.

The Boiler Code of the American Society of Mechanical Engineers prescribes that "Tension-test specimens shall be taken longitudinally from the bottom of the finished rolled material, and bend-test specimens shall be taken transversely from the middle of the top of the finished rolled material. The longitudinal-test specimen shall be taken in the direction of the longitudinal axis of the ingot, and the transverse-test specimen at right angles to that axis." When the sheet is curved, as is not usual, crosswise of the grain the tension-test specimens must be cut crosswise of the grain and meet the physical test prescribed. The bend-test specimen must bend cold through one hundred and eighty degrees without cracking, around a pin the diameter of which is equal to the thickness of the specimen for one-inch material and under or of a diameter twice the thickness of the plate if the latter is over an inch thick. There is no provision in the Code for any quench test.

The reference to the experience of the British Columbia Inspection Board with logging boilers made by curving the bottom sheet in the direction of the shorter dimension, eliminating the middle circumferential seam but having two longitudinal seams running the full length of the boiler, is interesting in connection with the discussion of the allowable length of longitudinal seams now going on in *Power*. We have asked Mr. Biggam to contribute at greater length to this discussion.

A. I. E. E. Proposed Changes in Activities

THESE are days of radical changes in about everything that affects the activities of groups of people, whether it be of nations or individual groups within the nation. Even bodies that in the past have been apparently immune from the influence of radical changes now find themselves carried along in the flood of unrest that is practically enveloping the world at the present time. The contemplated changes in the activities of the American Institute of Electrical Engineers, as proposed by the development committee and published elsewhere in this issue, are representative of the trend at the present time. Many changes have been made in the workings of the Institute since its founding in 1884, to meet the altered conditions in the electrical industry and the needs of the increased membership of the society, but none have been so radical, comprehensive and far reaching as the present proposed changes. Only the highest commendation is due the development committee for working out these changes to increase the usefulness of the society to its members. However, where such far-reaching changes are contemplated, they should be put into effect only after the most serious consideration.

An engineering society in the past has in general been looked upon as an institution apart from and entitled to and allowed privileges not granted to commercial organizations. What the effects of an attempt to commercialize the *Proceedings* of the institute would be is difficult to foresee. However, there are many members of the highest professional standing that are opposed to any such move, as they feel that the prestige and independence of the institute will be decreased. There is little doubt that many of the proposed changes, if put into effect, will enhance the value of the institute to its membership, but careful consideration should be given to the departure in policy, or else the work of the past thirty-five years of building the American Institute of Electrical Engineers up to its present high standing as a national technical society may be seriously impaired.

The latest estimate of the power used in the industries of the United Kingdom (exclusive of that used in blast furnaces, gas works, etc.) is given in the report of the British Government Coal Conservation Committee as 10,024,996 horsepower. From other sources it is estimated that for every person engaged in industry in the United Kingdom about one-half a horsepower is available, in Canada about three-quarters of a horsepower and in the United States one horsepower.

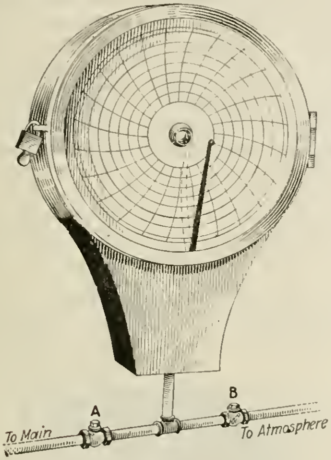
Periodically, peat has come to the foreground as a suggested substitute for coal in power generation, and in isolated instances it has been so used. but thus far it does not appear to have offered sufficient inducements to warrant adoption on a large scale. Reports now come from Moscow, however, that due to absence of water power and the gravity of the coal situation the Council of Public Economy of that city is now planning to erect a large electric power station near the peat beds.

In spite of pressing need for legislation and the momentous questions now before the Senate, that body has found time to again pass a daylight repeal bill. Judging from this the League of Nations, the railroad situation, the high cost of living and the need for water-power legislation all appear insignificant beside the invisible pressure that must be behind that extra hour of darkness. It is assumed, of course that the President will again use his veto power.

Correspondence

Check Valves in Recording Steam-Gage Piping

In order to protect a recording steam gage from the strain of having to stand under a vacuum, which was formed in a long steam main each time the line was shut off, a check valve, as shown in the illustration at *A*, was put in the line to the gage, as it was not desired to have the vacuum broken in the main stream line between the gage and the point of shutoff. It was then found that a vacuum still formed between the check valve and the recording gage and that it was strong enough to keep the pen pulled over to the center nut which holds the chart. This action, besides having a tendency to spring the pen arm, caused the ink to smear badly near the center of the chart and caused considerably inconvenience to the operator when renewing the chart, as the pen would be found sprung against the center nut instead of resting on the zero line, well away from the nut.



CHECK VALVE IN GAGE LINE

The arrangement of a second check valve *B* in the line to the gage, each check opening toward the gage, as shown, ended the annoyance. I. S. CHAMBERLAIN.

Jersey City, N. J.

Laundry Condensation Problems

In a certain large laundry the condensed steam from the ironing machines was handled by traps discharging into an open heater. A direct-return system, with a receiver located at the lowest point, was installed and all machines emptied into this receiver. This change resulted in a saving of thirty bushels of coal a day. Although the service was fairly satisfactory, there was always trouble with some of the machines becoming airbound and not heating properly.

Recently, a change in system was made whereby a non-return trap was installed for each machine and all traps empty into a steel tank located 12 ft. above the boiler and vented to the atmosphere. The tank empties into a direct-return steam trap, thence to the boilers. By providing a float valve for makeup water, the steam boiler-feed pump has been discarded.

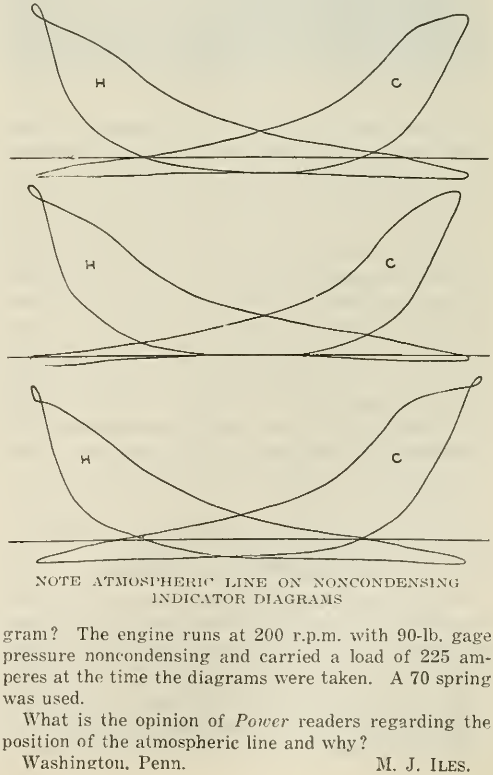
Although the condensed steam is now 212 instead of 280 deg., the efficiency of the ironing machines is so much greater that one machine increased its output from 23,000 to 40,000 pieces in nine hours.

The direct-return system is all right for one or two machines, but this system will give better results where there is a large number of machines.

St. Louis, Mo. H. C. JOHNSON.

Why the Atmospheric Line?

The accompanying indicator diagrams are submitted for criticism. The valve fitting can be easily improved, but that is not what is bothering me. The mystery about these diagrams is why does the atmospheric line appear, as is shown, on a noncondensing indicator diagram? The engine runs at 200 r.p.m. with 90-lb. gage pressure noncondensing and carried a load of 225 amperes at the time the diagrams were taken. A 70 spring was used.



NOTE ATMOSPHERIC LINE ON NONCONDENSING INDICATOR DIAGRAMS

What is the opinion of *Power* readers regarding the position of the atmospheric line and why?

Washington, Penn. M. J. ILES.

Connecting Cable to Live Bus

When electrical power plants or substations make changes, repairs or additions, it is often necessary to work on live circuits to avoid service interruptions. A little planning will at times bring to light some method to solve these problems without working on live equipment.

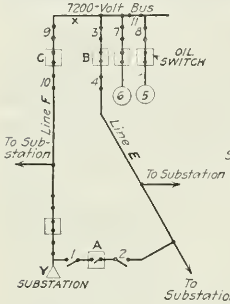


FIG. 1. NORMAL CONNECTIONS

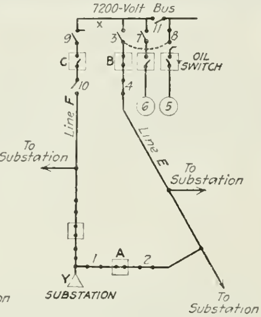


FIG. 2. EMERGENCY CONNECTIONS

Fig. 1 shows a single-wire diagram of a 7200-volt three-phase power system, the power plant of which contained six hydro-electric units. Another line was to be connected to the bus at *X*, between where lines *E* and *F* are connected. It was of the utmost importance to keep these lines alive while the new line was connected. The procedure was as follows:

First, the disconnecting switches 1 and 2 and the oil switch *A* were closed at the substation *Y*, thus connecting lines *E* and *F* together. Next, oil switch *B* was opened and then the disconnecting switches 3 and 4. This left line *E* alive through substation *Y*. The load being light at this period, generators 5 and 6 were shut down, and the generator's disconnecting switches 7 and 8 opened. No. 5 generator's cables were then taken off the disconnecting switches 8, and a temporary connection made between disconnecting switches 3 and 8, as indicated by the dotted line in Fig. 2. Disconnecting switches No. 8 on No. 5 generator oil switch and disconnecting switches No. 4 on line *E* were now closed and then oil switch *B* on line *E* closed, thus feeding line *E* again from the bus directly. The next operation was to open oil switch *C* and disconnecting switches 9 and 10 on line *F*. This left line *F* being supplied through line *E* around through substation *Y*. The last move was to open the bus sectionalizing switches 11, thus making the left-hand end section of the bus dead, as shown in Fig. 2. The new line was now connected at *X*, after which the reverse order of switching was followed to get the system back to normal operation.

Iron Mountain, Mich. L. W. Wyss.

Removing Retaining Wedges and Coils from Induction Motors

We are doing considerable repair work on induction motors and find it very difficult to remove the retaining wedges and coils from the stator slots without damaging them. I would appreciate some suggestions from *Power* readers as to their methods of removing the coils and wedges, especially when the windings have been impregnated with an insulating compound.

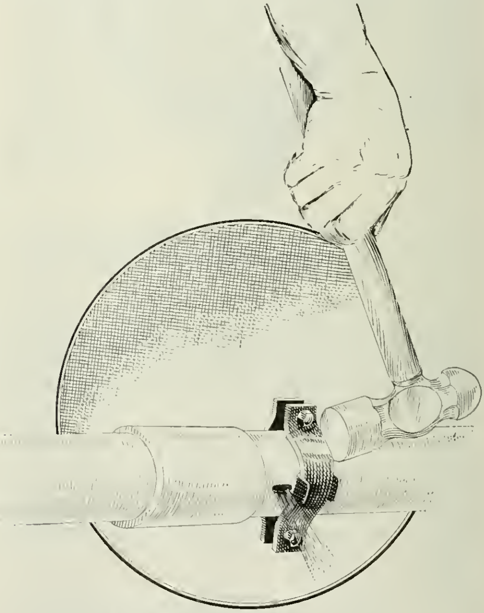
Dubuque, Iowa. W. J. Hohe.

Stopping Leak in Elevator Piping

During the noonday rush of elevator travel in a large office building the 8-in. main pipe that carries the water, under 300 lb. pressure, from the compression tank to the elevator cylinders suddenly began to leak. It was such a mishap as ordinarily puts a hydraulic elevator system out of operation for the time being; but in this case, owing to rapid action by the engineering crew, there was no interruption of the service, notwithstanding the pumps were strained to their utmost to supply the quantity of water that leaked out.

For a part of its length the main traverses the boiler room at the rear end. The leak occurred in this portion, the water issuing laterally from a hole nearly an inch in diameter, that appeared close to a coupling joining two sections of the piping. The colored coal passer, who was standing near-by when the water burst through, grabbed up a short board and undertook to check the flow by placing it over the hole. The instant the stream struck the board, the impact sent him tumbling a distance of twenty feet.

Luckily, there happened to be available a rivet-heating forge, fired up and in service at the time, which was being used in a repair job on one of the boilers. The engineer on watch took two pieces of 2 x $\frac{5}{8}$-in. flat iron that were handy and hastily forged them into the form of a band, punching the bolt-holes on the anvil, instead of drilling them, to save time. These were clamped around the pipe, over a liner of sheet copper which was turned up at the edges, and the tightened clamp was driven over the hole with a hammer, as indicated in the sketch. This improvised arrangement held, with considerable leakage, until the close of the day, when the copper liner was taken out and a piece of sheet rubber substituted.



HAMMERING THE CLAMP IN PLACE

A. J. Dixon.

St. Louis, Mo.

What Should Be the Maximum Length of a Longitudinal Joint in a Boiler?

Referring to the editorial in the July 1 issue on "What Should Be the Maximum Length of a Longitudinal Joint in a Boiler," I would say that when the 12-ft. rule was adopted by the Massachusetts Boiler Rules Committee it was impossible to procure plates rolled any wider than 12 feet. Plates up to 15 ft. wide are now obtainable, therefore the 12-ft. limitation has become out of date.

Any rule should be based not upon some condition of practice, but upon proper principles, and there are cases of construction, such as in the long steam drums of water-tube boilers, where the limitation of length to 12 ft. serves to weaken the construction by reason of the fact that a girth joint is provided in the center of the span of the drum, which involves a construction making the steam drum perform partly the function of a girder and, therefore, full-length course is much stronger and safer.

I understand also that the troubles with former single bottom-plate construction of horizontal return-tubular boilers was not because of the single-length bottom plate itself so much, but because at the time these installations were made plates could not be made wide enough to insure that the riveted longitudinal joints would be away from the direct action of the fire. But with wider plates now obtainable, this difficulty can be avoided and good, serviceable boilers built upon this plan.

I therefore consider that the rule as adopted by the A. S. M. E. Boiler Code Committee is much more suitable than its former rule and more suitable than the rule of the Massachusetts Board.

CHARLES L. HUSTON,
Vice President and Works Manager,
Coatesville, Penn. Lukens Steel Co.

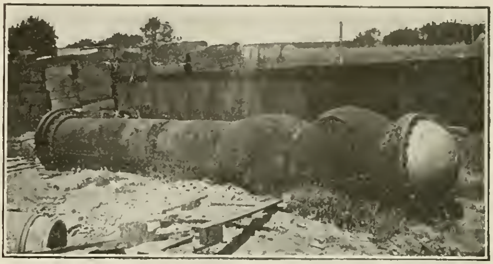
The editorial regarding the length of longitudinal seams is of great interest to all concerned with the operation, construction or insurance of steam boilers. As the editorial states, there should be some common ground in regard to this question that should be considered proper for all boiler rules governing construction.

During the last 20-odd years I have been situated so that I have had exceptional opportunities to investigate boiler accidents. Possibly the experience thus gained in regard to this question may be of interest to the readers of *Power*.

There appears to be no good reason to doubt that the long longitudinal seam of the lap-joint type for horizontal-return-tubular boilers has proved relatively unsafe. That the long longitudinal lap seam is unsafe only on the horizontal-return-tubular type of boiler is to be very much doubted.

The reason that it has obtained such an unsavory reputation in connection with its use on this type of fire-tube boiler is no doubt due to the fact that its use has been confined almost exclusively to such boilers. Long longitudinal seams of the lap type have been used to a considerable extent on a few types of water-tube boilers, and while some failures have occurred, they have not been frequent enough to attract attention. Possibly one of the reasons for the apparent better behavior of these long seams, in the case of the water-tube boiler, is that the diameters of the shells have been relatively small and the structure more rigid on this account.

In figuring the strength of furnaces to resist collapse, the length of sections between supported points is invariably taken into consideration. It has been found by experiment that until this length between supported points exceeds six diameters, it is a factor affecting the strength of the furnace. No doubt the reason that the length between supported points has always been considered a factor in furnace calculations is because the formulas governing such calculations have been derived from experimental data rather than from purely theoretical considerations of the subject. This has not been the case in regard to the calculated strength of boiler seams. That is, while experiments have been made to determine the actual strength of joints, these experiments have been on short sections of joints that could be pulled in a testing machine, and not by the application of a test pressure to a vessel in which the joint to be tested was applied. Invariably, where a test pressure approximating the bursting pressure is applied to a cylinder composed of courses, the material about midway between the girth seams extends more than at these seams, indicating a stiffening effect by the girth joints. This stiffening effect of the girth joint is well illustrated in the accompanying illustration, which shows an ammonia retort that was used in an ice plant, and under pressure at the time the plant was destroyed by fire.



SHOWING STIFFENING EFFECT OF THE GIRTH JOINT

The same result is to be noted in similar vessels when subjected to a hydrostatic test to destruction, but of course the bulging of the courses between the girth seams is not so pronounced. This would seem to indicate clearly that if two cylinders were of identical proportions, except that one was made up of several courses while the other was constructed of a single course, the former would be the stronger of the two. Most mills cannot roll sheets over 12 ft. in width. To make a joint over 12 ft. in length a sheet that is 12 ft. or less wide must be rolled crosswise of its grain.

An inspector, in recommending the removal of some old long-seam boilers, illustrated the lack of reliability of the metal when used with the maximum stress across the grain rather than with it, by striking a short piece of board across the edge of a work bench so that the bench edge and the grain of the wood were parallel. The board, of course, under this test split in two. A similar piece of board was struck with the edge of the bench at right angles with the grain of the wood, and of course this treatment did not produce any damage to the board. This illustration, while not accurately representing the condition with respect to the boiler plate, proved satisfactory to the owner and resulted in the much-needed retirement of some obsolete boiler equipment.

This difference in the strength of the plate at right angles to the way it was rolled is cared for in the A. S. M. E. Code requirements by specifying a test of the material in the direction of the greatest stress.

A further fact that seems to demonstrate the strengthening effect of short courses for boilers is that the old two-flue and cylinder types of boilers were practically immune to the defect known as the "lap crack." Such boilers were made in courses generally 24 to 30 inches in length and never more than 42 inches.

That long-seam boilers do frequently explode and with violent results may be seen from the following list of 14 explosions of boilers of this type of construction, which occurred in the decade from 1900 to 1909 inclusive: James Beach & Son, Dubuque, Ia.; Paxton Electric Light Co., Paxton, Ill.; Hayes Manufacturing Co., Erie, Penn.; Penberthy Injector Co., Detroit, Mich.; Park Steel Co., Pittsburgh, Penn.; Hilton Lumber Co.; Central Pennsylvania Light and Power Co.; Taylor Silk Mill, Taylor, Penn.; American Palace Laundry Co., Buffalo, N. Y.; J. N. Russell, Tipton, Ind.; Monongahela City Water Works Co., Monongahela, Penn.; Liverpool Salt Co., Hartford City, W. Va.; Trexler & Tunell Lumber Co., Ricketts, Penn.; and Radcliffe Mills, Shelton, Conn. The property damage that was occasioned by these explosions amounted to about $360,000.

It remains to be demonstrated whether the butt-strap type of construction for longitudinal joints will remedy the defects that have been found to exist with the long-seam construction using the lap type of joint.

The use of long longitudinal seams of the lap-joint type on locomotive or vertical tubular boilers should, in my opinion, show the same results as the use of similar seams on the horizontal-return-tubular type of boiler. Without doubt the reason why disastrous explosions have not been noted with as great frequency on the two former types of boilers is because longitudinal seams exceeding 12 ft. in length have rarely been applied to such boilers.

In the case of lap-seam cracks it is not usual to find that defects in the plate approach the girth seams nearer than 12 to 18 inches. This is another fact which seems to demonstrate the stiffening effect of girth joints which acts to prevent distortion of the shell plates in the vicinity of the girth seams.

S. F. JETER,
Chief Engineer, Hartford Steam
Boiler Inspection and Insurance Co.
Hartford, Conn.

Referring to the editorial on the maximum length of longitudinal joints of boilers in the issue of July 1, I have never known why the Massachusetts Rules limit the length of longitudinal joints of certain types of boilers to 12 ft., but have supposed that it is due to the fact that plates are often grooved (or used to be) in the direction of rolling because the steel mills do not (or did not) keep their rolls in good order. As the rolls are used, they wear unevenly and become grooved, and the result is that the plates are grooved. I have inspected a great deal of boiler plate at mills, have observed this, and have found that specimens cut at right angles to the direction of rolling do not show as much elongation as when cut the other way, because this phenomenon is confined to one of the short spaces between ridges. If this defect of plates is sufficient, it is just as bad in one kind of boiler as another and equally bad in steam drums of water-tube boilers. If it were not for this, I can conceive of no objection to as long longitudinal joints as can be made.

I think that boiler rules should permit longitudinal joints of any length provided the plates are not grooved to greater depths than might be prescribed.

It should not be supposed that boiler plates are perceptibly stronger in one direction than in the other because they are apparently rolled in one direction. In fact, they are rolled in both directions, although more in one than in the other. When an ingot is placed between rolls it is rolled sidewise and diagonally until it is sufficiently wide to insure the desired width of the plate, after which it is, of course, rolled lengthwise until it is reduced to the proper thickness. This renders the plate as strong and ductile in one direction as in the other except in so far as grooves localize the latter property.

While I have written as if the grooves are a serious defect, my private opinion is that they are harmless, for boilers do not explode from such a defect as this.

Philadelphia, Penn. F. W. DEAN.

Sodium Bichromate in Ammonia

In a circular sent out June 15, 1918, the United States Food Administration recommended the addition of one-half pound of sodium bichromate to each 100 lb. of aqua ammonia in the charge of an absorption refrigerating machine to prevent the formation of foul gas in the system and corrosion of the pipes and tanks in contact with the aqua ammonia.

I put about thirty pounds of this chemical into the system of the refrigerating plant under my charge and found that it prevented to a great extent the formation of this foul gas; but I would like to see the subject discussed in the columns of *Power* by other engineers who have used the chemical.

On washing out the machines last winter, I found considerable black deposit in the generators, etc., and on taking a sample of it to our chemist for test, he pronounced it iron oxide. We found it necessary to renew approximately 125 lead disks of valves on the generators, weak-liquor coolers, exchangers and other parts of the machine in contact with the aqua ammonia, but practically none where only gas came in contact with the disk. Two coils of our exchanger were corroded through and leaking and had to be cut out of service.

Wherever we have any leaks of hot ammonia, a sticky, whitish substance with a decided bitter, salty taste oozes out of the joint or stuffing-box that may be leaking, and I have not yet determined what this substance is.

We are now experimenting with adding caustic soda to the calcium brine solution to prevent corrosion of the brine piping and tanks. One of our tanks which forms an air chamber to smooth out the pulsations of the brine pumps corroded internally so badly that we had to cut it out of service.

We are looking for something that can be added to the aqua ammonia charge that will prevent entirely the corrosion of the piping and interior of the aqua pumps, etc. I would like to hear, through *Power*, from anyone feeling qualified to discuss the subject.

Brooklyn, N. Y. W. T. MEINZER.

Inquiries of General Interest

Frosting Back of Ice Machine—Is there any advantage in having the suction of an ice machine "frost back" to the machine? W. M. H.

Frosting back occurs because the cooling coils are not absorbing as much heat as they should. The liquid admitted to the cooling coils is not evaporated in those coils but some is carried over and evaporated in the suction line where cooling is not utilized, and the frosting back is of no advantage.

Distance of Pulley Centers for Motor Drive—What is the approximate rule for the minimum distance between pulley centers for open belt drives from small electric motors? H. P. R.

A rule that has given satisfaction with pulleys of usual sizes is that the distance between the pulley centers should not be less than three times the sum of the diameters of of the pulleys. A distance of four or five times the sum of diameters will result in a better drive.

Tilting Trap as Water Meter—Could not a tilting trap be used with a counter attached for metering the amount of feed water supplied to a boiler? C. C. G.

The amount of water discharged per cycle of the trap would be irregular unless special means were employed to render the friction of moving parts constant. With ordinary forms of tilting traps, the irregularity of discharge could not be accounted for with sufficient accuracy for testing without making calibrations so frequently as to render their use impractical.

Sufficient Size of Steam Pipe—How can it be known whether the diameter of an engine steam pipe is large enough? E. N.

The pipe should be so large that when the engine is carrying its fullest load, the gage pressure at the boiler side of the engine throttle valve will be not less than 97 per cent. of the gage pressure in the outlet side of the boiler stop valve. With steam pipes of ordinary length such a drop of pressure will not be exceeded, allowing for a velocity of steam in the pipe of 6000 ft. per min., a piston speed of 600 ft. per min. and cross-sectional area of steam pipe of about one third the diameter of the engine cylinder.

Slippage of Riveted Joint of Boiler—Is slippage of a riveted boiler joint an indication that the joint has been stressed to the point of failure? F. M.

In a newly constructed joint the resistance to initial slippage consists mainly of friction between the plates due to the longitudinal shrinkage of the rivets from cooling after they are driven. Some displacement of the plates must occur before the sides of the holes are brought to a bearing to exert a shearing action on the rivets, because the rivets in cooling also contract in diameter and do not completely fill the rivet holes. In American boiler practice the assistance that is rendered by friction between the plates is regarded as uncertain and the strength of riveted joints is based on resistance to stresses concomitant with shearing action on the rivets; and sufficient slippage for taking up bearings on the rivets that have been properly driven is only an indication that the rivets are in position for receiving the shearing stresses, and not that the joint has been stressed to the point of failure.

Obtaining Correct Gage Pressure—We have some low-pressure steam gages located about 10 ft. below the steam lines, that indicate about 5 lb. above the pressure of the steam. How can the gages be connected to show the correct pressure? E. W.

When a correct gage is placed below the pipe, the pressure indicated will be the pressure in the pipe plus the pressure due to the height of water column in the connection, measured from the bottom of the steam main to the center of the gage. Assuming that the temperature and density of the water in the connecting pipe are constant, the plus quantity will be the same for all pressures and the pressure indicated when there is only atmospheric pressure in the steam pipe and with the gage pipe filled with water will be the amount to be deducted from all reading to obtain the gage pressure in the steam pipe. If it is desired to obtain correct readings at sight, without making the subtraction, reset the gage pointer or supply the gage with an extra pointer, to indicate zero on the dial when the connection is filled with water and the gage pressure in the steam pipe is 0.

Keeping Motor in Service—How can a shunt- or compound-wound motor be started and kept in service if the starting box burned out? E. P.

The connections for starting a shunt and a compound motor with a water rheostat are shown in Figs. 1 and 2 respectively. The water rheostat is made from a bucket of water with a handful of common salt in it. It is preferable that a wooden bucket be used. One metal electrode is placed in the bottom of the bucket, and the other is gradually lowered into the solution at starting until the two electrodes are together. When the motor is shut down, care should be exercised to see that the top electrode is removed from the bucket, or the fuses will be blown if the switch is closed with the electrodes together.

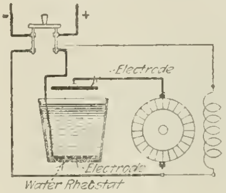


FIG. 1. CONNECTIONS FOR STARTING SHUNT MOTOR WITH WATER RHEOSTAT

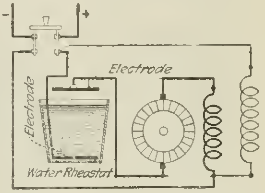


FIG. 2. CONNECTIONS FOR STARTING COMPOUND MOTOR WITH WATER RHEOSTAT

Scale of Indicator Diagram for Reduced Size of Piston—When indicators are quoted as having one-half or one-fourth size pistons, are the fractions intended to signify inches of diameter or relative areas; and when the smaller pistons are used, how is the scale value of the diagrams determined when the indicator is employed with a standard scale of spring? G. L.

Some indicators are made to receive pistons of smaller area than the regular or standard area of piston, by elongating the piston rod enough for a smaller piston to reach down and work in a part of the cylinder where the bore is one-half of one-fourth of the cross-sectional area of the standard piston. By reason of resisting pressure exerted on only one-half or one-fourth of the standard area, the effective scale of the spring thereby becomes twice or four times as great. Thus the scale of a diagram made with a spring whose scale is 40 lb., when used with the standard piston would be 2 × 40, or 80 lb. per sq.in. per inch rise of the pencil when used with a one-half size piston; and a 60-lb. spring used with a one-fourth piston would produce a diagram whose pressure scale per inch rise of the pencil would be 4 × 60, or 240 lb. per square inch.

The Corrosion of Metals*

BY GUY D. BENGOUGH, M.A., B.Sc., AND O. F. HUDSON, A.R.C.S., D.Sc.

THE report is divided into three main parts. The first is devoted to the question of the nature of the actions that take place when metals such as zinc, copper, aluminum, and alloys such as 70:30 brass, corrode in neutral or nearly neutral liquids, for example, distilled water and sea-water. The second section is devoted to the consideration of the behavior of condenser tubes in similar liquids, and the variations in behavior in different samples of tubes of nominally the same composition. In the third section an attempt is made to set out in some detail a statement of the practical problems of corrosion, which appear to the authors to be very different from what is usually supposed. A preliminary account is also given of experiments carried out with the object of testing an electrolytic (the Cumberland) process of protection. A preoxidizing protection process is briefly described.

PART I. THE NATURE OF CORROSIVE ACTION

The current theories of corrosion are briefly considered. The difficulties in the way of making a true quantitative determination of the amount of corrosion are discussed and shown to be almost insoluble in certain cases with existing methods of analysis. Mere "loss of weight" measurements, unsupported by detailed analyses of scale and metals in solution, are considered to be of little value in many cases, and might be replaced with advantage by microscopic work.

CAUSES OF CONDENSER TUBE AND FERRULE CORROSION (WATER SIDE ONLY CONSIDERED)

Cause	How Produced	Nature of Action	How to Be Remedied
A. Foreign bodies carried in and accumulation of products	A1. By ferric hydrate flakes from water ends A2. By ashes, clinkers, etc. A3. By sludge of sorts in water supply	Complete corrosion of the oxide disintegration type, causing local action	A1. Paint the pipe line and water ends Increase water speed A1, A2 and A3. If worth while trap the water supply or pass it through a screen. In some cases increase water speed
B. Acid or other bad or variable water supply	B1. Some river supplies, for example Tyne. B2. Some canal supplies, for example, ship canal B3 Some well supplies B4 Some estuarine supplies B5. Some cooling-tower arrangements	Complete corrosion and rapid general chinning. Sometimes slight uniform dezinicification	Keep water supply slightly alkaline Use special tubes adapted to the special conditions
C. Temperature in condenser too high	C1. Hot inlet water, for example, tropical C2. Slow water speed C3. Partial blocking of tubes	C1 Denzincification C2 Denzincification C3. See A3	C1 and C2 Use special tubes C2 Increase speed C3. See A3
D. Undue aeration	D1. Errors in pump and pipe line arrangements D2. Eddies near inlet causing water-line effect	D1. Complete corrosion of oxide disintegration type D2 Complete corrosion of pitted areas	D1. Remedy air leaks, etc. D2 Special ferrules. Possibly increasing speed of water with modified design of water end
E. Unsuitable composition of tube	E1. Zinc or impurities in too great amount E2. Surface of tube not sufficientlycopper-rich	E1. Varies E2. Dezincification	E1. In manufacturing E2. Probably by attention to details of annealing and pickling during manufacture
F. Defective packing of tubes	F1. Leaks caused by perishing of the packing material especially in acid water F2. Collapsing of tube	F1 Varies F2 Varies	F1. Use good tape packing Red lead is sometimes useful to prevent leakage F2. Do not crush tube when inserting it
G. Physically bad surface of tube; such as bad spills and laminations	G1 Foreign bodies caught and trapped which would otherwise be swept away	G1. Complete corrosion and oxide disintegration	G1. During manufacture
H. Theromo-electric action in condenser	H By steam impinging directly on tubes, or being improperly distributed	H. Denzincification	H1. Only occures in condensers of old design when steam is not properly distributed
I. Too slow water speed	I Gases given off inside tube and not immediately swept away	I. Complete corrosion near inlet end	I. Increase speed of water Do not use main condenser for auxiliary machinery import

The action of distilled water on metallic zinc has been studied in some detail, and the following conclusions have been reached. Metallic zinc is normally covered with a partially protective scale, which consists largely of oxide or basic carbonate. Water containing CO_2 can attack or dissolve the oxidized layer, and zinc can then be found in solution as a slightly soluble bicarbonate. The attack on the scale begins at certain points, and a true metallic surface is exposed to the action of the water. At such places a peculiar form of oxide is formed on the surface of the metal. Probably this oxide contains zinc peroxide and exerts a catalytic action on the underlying metal. It is slightly soluble and passes into solution, and is afterward largely precipitated as the ordinary hydroxide and carbonate. The precipitated hydroxide has a distinctly protective action on the metal beneath it and reinforces the original scale and enables it to resist the action of CO_2. The action is thus localized. In the presence of very large amounts of CO_2, as, for instance, when the water is kept saturated by bubbling CO_2 through it, the products of corrosion are largely kept in solution and local action is almost entirely avoided, though the total amount of corrosion that takes place is increased. This is due to the fact that almost the whole of the original scale is removed by the solvent action of the water, with the result that further oxidation of the metal can take place, and further solution.

In the case of very dilute acid, such as acetic, the action consists in the replacement of hydrogen by zinc, but the action is not severely localized as in the case of distilled water; there are no local accumulations of the products of corrosion, and consequently the action is much more nearly uniform. There is no evidence that dissolved oxygen can act as a depolarizer; hydrogen is given off as gas. The authors come to the conclusion that the initial action of distilled water on zinc is a process of chemical oxidation rather than electrochemical displacement. The action of sea-water on zinc is also chemical rather than electrochemical and local action in this case also is due to the local accumulation of certain products of corrosion. The action of distilled water on copper is also chemical oxidation. There is no preliminary electrolytic action, even in the case of a surface of metallic copper known to be free from oxide previous to immersion. The oxide formed over the general surface immediately after immersion is a lower oxide, either Cu_4O or Cu_2O. In course of time it becomes further oxidized at irregularly distributed spots, and the product thus formed does not protect the underlying metal from oxidation to the same extent as does the original tarnish layer. The dark oxidation product itself, which is probably a cupric hydroxide or basic carbonate, tends to flake off the metal, probably owing to the formation of bulky oxidation products beneath it. The latter are porous, and apparently amorphous, and probably act catalytically by increasing the rate of oxidation of the underlying metal.

The amorphous oxide is slightly soluble, but is finally precipitated from solution as crystalline cuprite, which has a lower solubility than the amorphous oxide. The result of the action, continued in time, is to cause shallow pits in the metal. Such pits are much less important than in the case of zinc. In the case of some further experiments, however, this pitting action was not developed, and the

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*Fourth report of the Corrosion Committee of the Institute of Metals. General summary forming conclusion of paper read before the Institute of Metals on Mar. 25. The report itself extends to so great a length that it is not possible to publish it *in extenso*.

only action that could be observed was the formation of thick layers of oxide over the whole surface of the metal. These layers do not necessarily remain of uniform thickness over the whole surface of the specimen, but pronounced local action does not occur. In rare cases appearances are found on metallic copper, which the authors have only been able to interpret on the assumption that they are little electrolytic cells,[1] but the phenomenon is so rare that it is unimportant in comparison with the main action already described.

The principal action of sea-water on copper is again one of chemical oxidation. The action may be localized by the accumulation of products of corrosion, under certain conditions.

It has been found that the aëration of one of a pair of copper electrodes causes that electrode to be slightly electropositive to the other. The effect on the rate of corrosion of the em.f. so set up was, however, found to be quite small and less than the effect of other physical factors, such as the rate of flow of the corroding medium and the degree of aëration. The conclusion has been formed that differences in the rate of oxidation have a greater effect on the amount of corrosion than small differences of potential.

A number of experiments have been made on the effect of coupling together electrodes of different metals, and immersing them in different electrolytes. The behavior of such couples was by no means always such as would be expected from electrode potential lists. In some cases the couple behaved in the reverse way to that which was expected, and in others the effect of the couple in increasing corrosion was much less than expected. The effect of a couple is greatly decreased if the contact between the electrodes is not very carefully made. It is probable that the effect of couples in some of the practical problems of corrosion has been over-emphasized rather than the opposite, as sufficiently good contact for large effect does not usually occur. It has been definitely established that a metal may be oxidized and pass into solution in spite of the fact that it has been continuously maintained as a cathode, and the laboratory result has been confirmed on the practical scale by experiments carried out with an electrolytic protection of condenser tubes (the Cumberland process).

A preliminary study of aluminum and certain light alloys in distilled water and sea-water has been carried out. Local severe pitting at or near the water-line is described and discussed. It is shown to be due to the presence of a strongly acid salt.

An attempt is made to introduce a definite system of nomenclature into the terms used in the study of the corrosion of binary alloys, in order to avoid the confusion which at present obtains. In certain cases precise definitions cannot be formulated, as in the case 70:30 brass, owing to the difficulty of distinguishing between residual metal and redeposited metal.

The nature of the action of distilled water on 70:30 brass has been studied in detail by means of the microscope and analytical methods. The action is considered to be the chemical oxidation of the copper and zinc, and the partial solution of the oxidized products. Much of the zinc passes into solution, in the presence of CO_2 and part of the copper, the remainder of both metals remaining on the surface of the alloy as an oxide scale. The scale becomes further oxidized and altered at certain spots which become covered with thick deposits of the products of attack. Such deposits are porous and allow, and probably accelerate, local attack on the underlying metal. The attack is accompanied by redeposition of copper by displacement by the zinc either electrochemically or otherwise, and precipitation of cuprite. There are signs of slight local dezincification at such places, but the attack over the general surface of the alloy is complete corrosion. The positions at which local attack and pitting take place are not determined by the variation in the electrical properties of the original metal, but by the conditions of the experiment. In the presence of dilute acids, such as HCl and H_2SO_4, local action of the type described does not occur, since there is little or no local accumulation of oxidation products. On the other hand, the absence of CO_2 retards the action. From the analytical data it appeared that the local action in the case of distilled water increased with time, while the rate of general corrosion over the whole specimen fell off. These facts suggest the fallacy of loss of weight tests, since local action is more important practically than general corrosion.

The action of sea-water on brass has been studied on the same lines as that of distilled water. The action is considered to be similar in type. Local pitting and dezincification are due to the accumulation of the products of corrosion. Under certain conditions redeposition of copper may occur. The rate of general corrosion is much greater than that in distilled water, and does not fall off so rapidly with time. At the ordinary temperature there is less tendency to local dezincification.

Part II. The Corrosion and Protection of Condenser Tubes

The form of the surface of certain condenser tubes of 70:30 brass has been studied in detail. The presence of a layer that differs in its behavior toward corrosive agents from the underlying metal has been identified in several different ways. In many cases this layer is probably richer in copper than the alloy beneath it. In such cases the tube may resist dezincification in a marked degree for long periods; in other cases the surface layer probably has nearly the same composition as the rest of the tube, and in such cases strong dezincification may take place in sea-water in the neighborhood of 50 deg. C. Tubes from the same batch of manufacture usually resemble one another as regards the nature and properties of the layer, and tubes from different batches, even though made by the same maker, may differ. Thus one important factor as regards dezincification is the nature of the tube, but the kind of surface that best resists dezincification does not necessarily best resist other kinds of attack. Means of controlling the surface layer have not yet been worked out, but the problem does not appear to be insuperable and is receiving attention. The condition of the surface layer should be adapted to the conditions under which the tube will be used.

In many cases local action may be initiated on condenser tubes by the action of certain bodies, which themselves appear to take no direct part in the action. Such bodies are sand, calcium carbonate, ferric hydrate, glass, clinker and coke. The amount of action that takes place varies with the physical properties of the substance. The action is associated with the accumulation of products of corrosion and may be largely assisted by them. The nature of this action is of well-marked type, and has been provisionally called oxide disintegration. It is usually characterized by intercrystalline oxidation. Actions of this kind are of great importance in many cases of corrosion on the practical scale.

A preliminary study has been made of the action of very dilute acids on copper, 70:30 brass, and Admiralty alloy. The matter is important technically, because supplies of water in certain parts of the country are slightly acid in character. The strengths of acids used were between 5 and 10 parts of acid in 100,000 of water. Both HCl and H_2SO_4 were used. Acids of these strengths greatly accelerate corrosion and alter the type of action. The attack of the two acids, even when of equivalent strength, differs both in extent and character, that of HCl being greater and more selective. Admiralty condenser tube was decidedly more resistant than 70:30 brass to the action of dilute acids.

Part III. Notes on Practical Problems of Corrosion

Part III of the Report deals with the subject of corrosion under practical conditions as it appears to the authors. The views expressed are founded upon their general experience both in the laboratory and in connection with working conditions of actual plants. Unfortunately, the conditions in a practical plant are never known in full detail. Evidence as to the cause or causes of corrosion usually rests on a comparison of the corroded tube with others which appear to be similarly attacked under conditions that are more precisely known.[2] The degree of probability, therefore, which attaches to these views must be regarded as lower than that based on conclusions drawn from laboratory experiments.

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[1] These appearances are only found after oxidation to dark oxide etc., and not in the earlier stages of corrosion.

The authors express the view that corrosive attack on condenser tubes is more diverse in character and complicated in nature than has been generally supposed. The first action is one of chemical oxidation, and secondary actions are of great importance. No one single remedy is likely to be found effective for all the different kinds of attack which occur in practice. The nature of the tube used and the protective measures chosen should be dependent on the particular set of conditions.

The following is a set of conditions under which a 70:30 brass condenser tube should have a minimum life of 20 years:

a. Only clear water to enter the tube, or water which will not deposit suspended matter.

b. The water must be free from gases in suspension, and must not contain more than the normal amount of air in solution.

c. The water must be neutral or not more than very slightly alkaline. It must be free from ammonia and certain other specially harmful substances, which are, however, comparatively rare.

d. The temperature of the cooling water in the hottest part of the condenser should not exceed 35 deg. C.

e. The speed of the water should be about 5 or 6 ft. per sec.

f. The steam should be properly distributed in the condenser, according to the best modern practice.

A water supply which varies considerably in composition at different times of the year involves special problems and must therefore be excluded from the above statement at present.

In practice tubes fail sooner than the period stated, because the normal slow roughening of the tube by chemical oxidation is locally speeded up by factors which are for the most part independent of the tube. It will be noticed that this way of treating the subject is the inverse of that usually adopted. A preliminary attempt is made to gather the more important of these factors into a tabular statement, given on a preceding page. The statement is to be regarded as a skeleton structure, which will be amended and filled in as experience accumulates.

In practice factors set out separately in the table may act jointly. Causes of corrosion are not arranged in the table in order of importance, since the order varies in different types of installation. The effect of water speed on the rate of corrosion is briefly discussed; its effect varies with the type of corrosion.

The effect of the presence of a scale on the rate of corrosion is considered to be of great importance. Of the substances that commonly occur in scale, calcium carbonate is one of the most important. Its effect varies with its physical condition. It may exert almost any kind of effect from a considerable degree of protection to a serious attack.

Some observations are described on the effect of a form of electrolytic protection (the Cumberland process) at the Southwick Power Station of the Brighton Corporation, which is under the charge of J. Christie, who has placed many facilities at the authors' disposal. The conclusion is reached that the process insures a prolonged life for the tubes under Southwick conditions, provided that it is applied to new tubes, that is, to tubes that have not begun to corrode before the process is in operation. The process should be applied continuously and not intermittently. The authors consider that the thin uniform scale that is maintained on the tubes by the process is an important factor in preventing serious corrosion. One of the important functions of the scale is to prevent contact between the tube and harmful deposits and products of corrosion; in addition it slows down, but does not entirely prevent, the general oxidation of the tube. The authors consider that further evidence is necessary before the value of the process can be estimated as regards prevention of corrosion in certain types of water other than ordinary sea-water, and in the presence of deposits other than those which occur at Southwick. Other possible methods of protection are briefly considered, and a preliminary account is given of a preoxidizing process for reducing the rate of corrosion.

American Institute of Electrical Engineers Proposes Changes in its Activities

At the annual convention of the American Institute of Electrical Engineers held at Lake Placid Club, June 24-27, 1919, three sessions were devoted to a discussion of the changes in the institute's *Proceedings* and other activities as proposed by the development committee. The changes proposed by the committee are given in the following:

I. PUBLICATION

(a) Entirely change the character and form of the monthly publication by adopting the so-called standard technical publication size (9 x 12 in.), enlarging the editorial and executive publication staff, and make every effort to develop this publication into the best possible engineering magazine without in any way lowering the institute's standards.

(b) Eliminate therefrom the publication of papers except institute and occasional papers of unusual broad general interest or value. Substitute a set of abstracts of perhaps one-half page each of every paper presented to every section so that each month there will be a complete record of this class of institute activity.

(c) (New clause.) Print the *Proceedings* in two sections bound together into one publication when issued, but so arranged that they may be later separated by the recipient who may wish to dispense with that part made up of temporary matter and retain that part containing matter of permanent value. Publish in later issues of the *Proceedings* all discussions of papers previously appearing in full.

Note. The cost of printing, binding and distributing *Annual Transactions* now averages $18,000. It is thought that this amount of money can be expended with better results to the membership if the above plan will be acceptable to the membership in lieu of the present practice.

(d) Substitute for (c): Create a special committee which, after a definite general publication policy shall have been adopted, shall study all questions concerning the publication, free distribution, sale, etc., of papers not printed in the *Proceedings*.

(e) Formerly (d): Employ as a part of the magazine staff the best advertising solicitors obtainable and endeavor to make the publication a large earner. With the example of the American Society of Mechanical Engineers and the National Geographic Society before us, it is believed that a substantial profit can in time be realized by this means, and if so, it is proposed to allocate a liberal part of such profit pro rata to the various sections.

II. ORGANIZATIONS

(a) Create a New York section, to be organized and conducted on the same lines as existing sections elsewhere.

(b) Discontinue holding monthly institute meetings in New York and inaugurate the policy of holding institute and directors' meetings successively in different parts of the country where local sections are established. It may be desirable to reduce the frequency of institute and directors' meetings and hold them every two months or perhaps even less frequently instead of every month as now.

(c) Divide the country into geographical divisions corresponding in number to the number of institute vice presidents. If more than six divisions should be thought desirable, they should be established and the number of vice presidents increased to correspond. In order to allow for the future shifting of membership density and at the same time to escape the necessity of cumbersome constitutional amendments, the number and delimitation of geographical divisions should be specified in the by-laws instead of the constitution, to provide for ready amendment by the board of directors.

(d) Select one vice president from each geographical division. Continue to elect the president and managers from the membership at large as at present.

Note. The legaltity of electing directors to an organization chartered under the New York State law in any other way than by the vote of the entire membership is being investigated by counsel.

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[2] Much of the evidence cannot be satisfactorily reproduced either photographically or by any other other means known to the author. It is obtainable only by personal examination of tubes

(e) Pay the traveling and living expenses of the officers and board members when attending institute meetings. It is hoped that by the payment of these expenses and by a reduction in the number of institute meetings held each year a full attendance can be secured and all parts of the country be better represented.

(f) Make it the duty of each vice president to visit the sections in his own division at least once a year. Of course, it would also be desirable if the vice presidents could exchange visits.

(g) (New section.) Increase the vice presidents' term of office from one year to two years and remove the constitutional inhibition against the election of a vice president as manager. Provide against perpetual tenure of office by a constitutional provision that, except in the case of a manager or a vice president who may be elected president, no member may continuously hold office longer than for six years.

III. ACTIVITIES

(a) Decentralize committee work as far as it may be found feasible and desirable by substituting section committees for institute committees. Appoint a general committee to study this question and make recommendations.

(b) Present more high-grade papers of general engineering interest.

Note. The clause as originally worded gave the impression that the standard of the institute papers was to be lowered instead of broadened.

(c) Create a committee in each section charged with the duty of assigning to the younger members specific participation in designated meetings by the preparation of papers, discussion or otherwise. It is hoped by this means and by the appointment of a reasonable number of the younger men to the larger committee membership caused by decentralization that the interest of the younger men will be stimulated and their loyalty increased.

IV. LOCAL FEDERATION

(a) Prepare a comprehensive but flexible uniform outline for the federation of local engineering bodies, taking advantage of the experience already gained by existing affiliations.

(b) Use our endeavors to have the other national societies establish and support local sections along lines similar to ours, but do not confine local federations to such branches, rather planning to include all the worthy engineering bodies.

(c) Wherever such federation can be organized, establish under an appropriate name a federated local council of engineers to be made up of a properly apportioned number of representatives from the different locals.

V. NATIONAL COUNCIL

(a) Establish a direct touch between each local federated council and a National Engineering Council composed of delegates from as many national engineering societies as are willing and worthy to participate.

(b) Through the medium of the national and the local federated councils perfect a working arrangement for engineering coöperation in all public affairs where such is desirable.

VI. ENGINEERING CONGRESS

Endeavor to inaugurate the custom of periodically holding an engineering congress, the delegates to which should be selected from all parts of the country under a plan to be developed for suitable representation, this congress to consider and take action on such matters of general interest to engineers and to the public as may merit its attention and as have been previously advertised for a sufficient length of time to permit locals everywhere to give them consideration and when possible to send instructed delegates.

Note. Many suggestions have been offered regarding the details to be considered in carrying out the plan outlined in Sections IV, V and VI, but inasmuch as progress can be made only by and with the coöperation of the other founder societies, it has been thought best not to attempt to specify details in our recommendations, but having expressed approval of the general plan outlined, to leave the working out of such details to our conferees.

It is estimated by French engineers that it will take ten years to restore completely the production rate of the mines destroyed by the Germans in northern France. In one mine alone, there is 20,000,000 cu.m. of water due to destroyed shaft linings and to that ditched in from surface ponds.

Swedish Developments in the Use of Electric Power

A bulletin issued by the Guaranty Trust Co., of New York, states that probably in no other country in the world, with the possible exception of the neighboring state of Norway, is there more intensive development in progress in the utilization of electrical energy than in Sweden.

There is in Sweden a remarkable tendency to apply the use of such power to every phase of the economic life of the country—to industry, to public utilities, to state and privately owned railroads, to agriculture and to home life in remote districts as well as in the cities. The importance of the development is out of all proportion to population.

Sweden possesses some coal, but it is not of the highest quality and the supply is inadequate for domestic needs. Her immense forests are her greatest present source of national income, but the day has passed when wood fuel can be broadly and economically employed. War markets afforded great incentive to the expansion of old and new industries, yet the difficulty and cost of importing raw materials, especially coal, created a handicap that would have been insurmountable but for the driving power at hand in the Swedish lakes and streams.

Great strides in water-power development were made during the war, and greater developments are planned. There is no desire to repeat the war experience of running her railroads on wood, 40,000,000 cu.m. of which was consumed in 1917, or upon imported coal at 175 crowns ($46.90) per ton, the price in October, 1918. Power, comparatively cheap, abundant, and available with little regard to conditions abroad, will assist immensely in realizing the industrial and commercial possiblities of her future.

The amount of water power normally available in Sweden may be conservatively set at 5,000,000 hp. Such a figure places her above any other country in Europe in this respect, with the exception of Norway. Water power has been used in her industries for centuries, and before the outbreak of war produced more than half the mechanical power in the country, the total consumption exceeding a million horsepower.

Heretofore, Sweden has paid heavy toll to Germany for her lack of direct shipping connections with outlying countries. Plans now being formulated will bring Swedish ports into direct and regular communication with this country, and the new policy of her big men is predicated upon the cultivation of closer commercial and financial relations with the United States.

Prior to the war our part in supplying electrical equipment to Sweden was almost nil. It is only in the past two years that our share has grown appreciably and it would appear to be entirely up to the American exporter of these commodities whether the figures rise to new heights or fall back to their old level. In 1917 our total exports of electrical goods amounted to $155,949.

It has been announced that Dwight P. Robinson & Co., Inc., 61 Broadway, New York City, have been awarded a contract by the Duquesne Lighting Co., of Pittsburgh, to design and construct a power station at Cheswick, near Pittsburgh, to have an ultimate capacity of 300,000 kw., of which one unit of 60,000 kw. is to be installed initially. The work consists of a new power-station building with the necessary complement of boilers, piping, electrical apparatus, coal-handling devices, coal storage, etc. It is anticipated that the work of installing the first unit will require about twelve months.

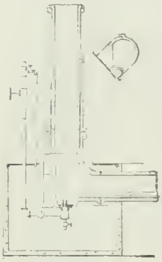
The Kentucky and West Virginia Power Co., with main offices in Philadelphia, has incorporated at Hazard, Ky., with a capitalization of $6,000,000. The company takes over the Kentucky River Power Co., of Hazard, the Tug River Electric Co., of Spriggs, W. Va., and the Logan County Light and Power Co., of Logan, W. Va. The total cost of this purchased property was approximately $2,500,000

Condensed-Clipping Index of Equipment

Clip, paste on 3 x 5-in. cards and file as desired

Conveyor, Improved Girtanner Ash

Girtanner Engineering Corporation, 1400 Broadway, New York City. "Power," July 1, 1919

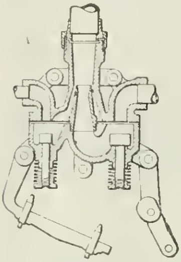


Improvements in this system are: Intake opening 50 per cent. greater area than the pipe; horizontal pipe made in 18-, 24-, 30-, 36-, 48-, 60- and 72-in. standard lengths; pipe joints made tight by means of ½-in. round asbestos gasket fitting in diamond-shaped grooves cast in face of the flange; ash-intake members designed 36 in. long with the intake opening 3 in. out of center; cover plate also made with opening out of center; turning each end for end to permit of any adjustment within 1 in at any part of 6 ft.; the bottom of the horizontal pipe is reinforced by liners 18 and 24 in. long; a special horizontal-vertical elbow, fitted with a target plate, can be removed without disturbing the rest of the piping and is fitted with a steam nozzle that can be removed through an opening without breaking the steam-pipe connection.

Discharger, Emergency

Emergency Devices Corp., 108-110 West 34th St., New York City.

"Power"

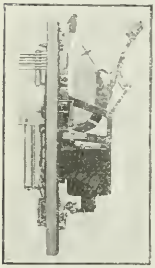


This emergency discharger is designed to control the removal from containers of dangerous liquid, gases, etc., in case of accident, from one or more remote safety stations. It is an ejector with two inlets, one for ammonia and one for water, both of which are controlled by valves, closing on their respective seats by screws carried in a swinging yoke that is held closed by a latch. Pulling on a wire cable attached to the trigger on the valve causes the latch to trip, allowing the yoke to swing back and release the valve. The pressure of water and ammonia and the action of the springs open the valves and permit the liquids to combine and pass through the injector, which discharges through a pipe connection to a convenient point.

Circuit-Breaker, New Type of Reclosing

Automatic Reclosing Circuit-Breaker Co., Columbus, Ohio.

"Power," June 24, 1919

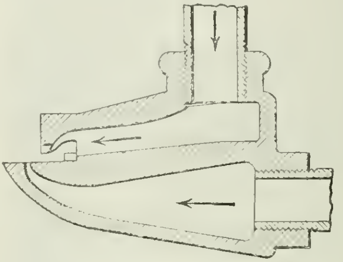


An electromagnetically operated circuit-breaker built in 3000- and 4000-amp. capacity. It is closed and held closed by an electro magnet, and opens automatically in case of overload, short-circuit or voltage failure, and remains open a definite time interval regardless of the cause of opening. The main contact brush is protected from arcing by an auxiliary copper contact shunt, and its final arc is taken care of on the upper graphalloy contact lips. Is adapted for heavy work such as steel mill and railway service.

Burner, Fan Tail, Fuel Oil

John Foerst & Sons, Bayonne, N. J.

"Power"

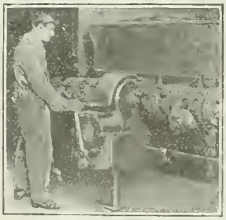


Constructed so as to eliminate wearable parts, stuffing-boxes and regulating cocks, and the arrangement of the stream-controlling surface prevents any possibility of the flame shooting upward against the boiler tube, and produces a fan-shaped flame. The advantages are: Great evaporating power, reasonable cost, easy to install, cannot clog or leak, simple and durable and no adjustment of fuel or air valves every few minutes.

Gear Box, Riley Two-Speed

Sanford Riley Co., Worcester, Mass.

"Power," July 1, 1919

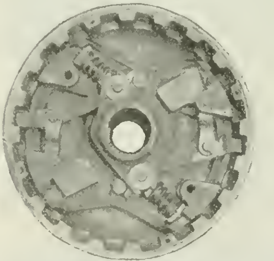


The Riley two-speed gear box contains in addition to the worm gearing a double set of spur gears so arranged that by shifting a lever from the high to the low position or vice versa the coal speed is increased or decreased. With this device an over-all range of speed of 4 to 1 is obtained. A simple throw of the shifter lever from left to right cuts the coal supply in half. This is done without changing the speed of the motor. The device is so constructed that it may be applied to any type of Riley stoker.

Release "Lettgo" Mechanical Overload

Frank E. Aurand, 123 South Cuyler Ave., Oak Park, Ill.

"Power," July 8, 1919

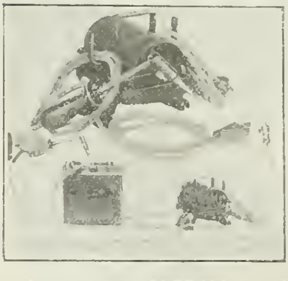


"Lettgo" is a device that will automatically disengage the driving power from the driven machinery, if the load exceeds a predetermined amount. The springs are arranged to adjust the tension so that the release will operate at the proper load and maintain a proper factor of safety. The mechanism is inclosed so that it can be packed with grease for lubricating. The triggers pivotally mounted on a link with the ends engaging inside notches in the rim of the drum and roller form the driving element. When the drive is overstrained, the compression of the springs will permit the ends of the trigger to drop into the release position, and the driving machinery immediately stops.

Transformer, Lead-Burning

General Electric Co., Schenectady, N. Y.

"Power," June 24, 1919

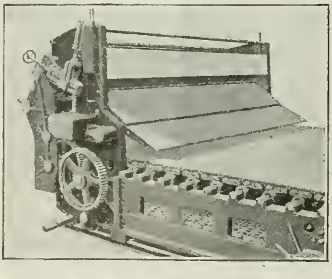


This transformer is designed for burning terminals in place on storage batteries, etc. It is connected to the ordinary 110-volt alternating-current lamp sockets, a 10-ft. cord and plug being provided for this purpose. Two separate rubber-covered terminal leads are used to convey the low-voltage heat-producing current to the part of the battery to be welded. When the pointed arc-welding carbon is brought into contact with the lead, the pointed end becomes so hot that it melts the lead over a restricted area quicker than a pointed gas flame will.

Chain Grate, the Coking Coal

Green Engineering Co., East Chicago, Ind.

"Power," July 1, 1919



This stoker is provided with a horizontal bedplate, over which coal is pushed into the furnace, an inclined adjustable bedplate directly below this and an oscillating plate below the adjustable bedplate. Fuel is pushed from the stoker hopper by a pusher that is divided into sections having variable stroke mechanisms, so that the amount of fuel fed to any section of the grate is independently controlled.

Patented Aug. 20, 1918

Some Factors in Boiler Practice*

By F. A. Combe

Engineer for Canada, Babcock & Wilcox Co., Ltd.

There is little difference in temperature of the water throughout any part of a well-designed water-tube boiler, the circulation being caused by a pumping action set up by the steam bubbles, in a similar manner to an air-lift pump, either in the front tubes of a vertically inclined tube boiler, or in the uptake headers of a sectional horizontally inclined tube boiler, and, as with an air lift pump, the rapidity and efficiency of the pumping action is dependent on the avoidance of large chambers in the water passages in which eddies and down currents impede the pumping action. Tests recently carried out on a horizontally inclined tube boiler of the header construction, 28 tubes high, showed that this pumping action amounted to the equivalent of some 18 in. of water head when the boiler was operating at rated capacity and that it increased progressively as the load increased.

The amount of heat absorbed by the surface of the tubes directly exposed to radiant heat from the furnace is generally proportional to the difference of the fourth powers of the absolute temperatures of the two surfaces, or = $C(T^4-t^4)$ where C is a constant for any unit of surface and time. The laws governing radiant heat or heat rays are analogous to those for light, the heat transfer being extremely rapid, but the great proportion of the heat energy is supplied by the obscure or dark rays.

In a Babcock & Wilcox boiler the amount of water evaporated per hour per square foot of surface of the lower rows of tubes exposed to furnace radiation, with a furnace temperature around 2500 deg. F. is at least from 50 to 65 lb., and as this may represent over one-half the total evaporation of the boiler at normal rating, the importance of a full knowledge of the subject of radiation is evident, while it incidentally shows how high the evaporative capacity of a tube is, and that an average evaporation rate of 3½ lb. per square foot heating surface for the whole boiler gives no indication of the amount of work any part of the heating surface is doing.

With a standard setting of boiler designed for 10 sq.ft. of heating surface per boiler horsepower, or an equivalent normal full load evaporation of 3½ lb. per square foot heating surface, and a ratio of heating surface to grate of about 50 to 1, the maximum combined efficiency will usually be maintained fairly constant from 90 to 130 per cent. rating. Below 90 per cent. rating the loss in efficiency is chiefly due to incomplete combustion in the furnace and grate and above 130 per cent. rating chiefly due to the increasing exit-gas temperature, the furnace and grate having then reached their highest efficiency. For other proportions and designs of boiler and furnace the point of maximum efficiency will be different.

Not many years ago the ratio of cubic feet of furnace volume to square foot of grate usually provided was 3 or 3½ to 1, whereas today we may have 5½ or 6½ to 1 for natural-draft stokers and even more for forced-draft stokers, particularly when high overloads are demanded. In the Detroit Edison boilers the ratio is about 9 to 1.

The best method of passing the gases over the tubes, and the relative advantage of different form of baffling have been discussed at various times, but it seems reasonable that a cross-flow over several passes of staggered tubes avoids stratification by insuring the most thorough breaking up of the gas currents, with the consequently better contact of all particles with the walls of the tubes, while with the first pass at the upper end of the tubes, a contraflow action to the circulation of the water in the boiler is obtained and, at the same time, with a horizontally inclined tube boiler, the circulation will be improved and the danger of blistering the lower row of tubes lessened by procuring quick release from tubes of steam bubbles formed.

In a paper read before the British Institute of Civil Engineers about a year ago, details are given of a test made on a B. & W. cross-drum boiler with integral economizers containing 4963 sq.ft. boiler-heating surface and 4086 sq.ft. economizer surface, in which a thermal efficiency of 88.33 per cent. for the unit was obtained, the exit-gas temperature being 293 deg. F., and the evaporation per square foot boiler-heating surface 9.53; while another test made in 1916 at the Hague municipal plant with a slightly smaller unit gave an over-all efficiency of 88.41 per cent. It is probably not possible to obtain such efficiencies with the coals usually obtainable here, but it indicates that a very high efficiency in steam-generating equipment has been reached.

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*Excerpts from a paper before the Engineering Institute of Canada.

New Publications

ANALYSIS OF BABBITT. By James Brakes. Published by Allen Book and Printing Co., Troy, N. Y., 1919. Cloth, 5 x 6½; 169 pages.

The purpose of this work is to place before engineers and others who have had training in chemical analysis, a small practical book on the analysis and manufacture of babbitt metal. The value of a handbook that points out accurate methods of analysis of metals will appeal to those having a desire to duplicate bearing metals that have proved satisfactory in practice. While the bulk of the work is devoted to technical chemical analysis of babbitt metals and the usual ingredients, the notes on the manufacture of babbitt are of especial value to those who have occasion to make mixtures for themselves.

Obituary

Charles Paul De La, of Yonkers, N. Y., a boiler inspector employed by the Employers' Liability Corporation, Ltd., of London, England, and New York City, was suffocated in a boiler at Newburgh, N. Y., Sunday morning, July 27. His body was dragged from the interior of the boiler which he was inspecting, when after an unreasonable length of time he failed to come out. In an unconscious condition he was rushed to St. Luke's Hospital at Newburgh, where he expired. Mr. De La was born in Newark, N. J., and had resided in Yonkers for 25 years. He was well known in this section, where he has been employed by the liability corporation for the last six years, prior to which he was an electrical foreman at the Yonkers branch of the Otis Elevator Company.

Personals

M. S. Sloan, who was operating manager of the New York Edison Co., has been elected president of the Brooklyn Edison Co., succeeding Nicholas F. Brady, resigned.

Fred J. Miller, formerly employment manager for the Remington Typewriter Co., has become associated with H. L. Gantt as a consulting engineer in the Singer Building, New York City.

A. W. Houston has resigned his position as vice president and general manager of the Texas Gas and Electric Co., at Houston, to accept a similar position with the Southern Utilities Co. Mr. Houston will have his headquarters in Palatka, Fla., and will have supervision of plants of the Southern Utilities Co., in Florida and Georgia. He will be succeeded by H. F. Cameron, of the Lake Charles Railway, Light and Power Co.

Lewis S. Maxfield has resigned as assistant to the secretary of the Heating and Piping Contractors National Association to accept a position in the office of the mechanical engineer of the New York Central Railroad.

R. Sanford Riley, president of the Sanford Riley Stoker Co. and the Murphy Iron Works, sailed for Europe on July 26 abroad the "Aquitania." Before his departure he was appointed honorary vice president of the A. S. M. E. He will represent the society and this country at the James Watt Centennial, which is to be held at Birmingham, England. He expects to return about Oct. 1.

Thomas O. Morgan, until recently head of the Service Department of the New York office of the American Steam Conveyor Corp., has been promoted to the position of sales engineer. He will handle Long Island and Connecticut territory.

H. S. Valentine, who has been connected with the Link Belt Co. for the last 5½ years, has been appointed sales engineer in charge of Philadelphia territory for the American Steam Conveyor Corp.

George B. Allan, Texas representative of the Yarnall-Waring Co., Philadelphia, who has been located at 305 Southern Pacific Building, Houston, Tex., will hereafter make his headquarters in Dallas.

Engineering Affairs

The American Association of Engineers, Nickel Plate Section, held a special meeting on July 24 and adopted a constitution and completed the organization of the section. The officers elected are: President, G. H. Trinker; vice president, W. H. Burrage; secretary, Ernest R. Taylor; treasurer, C. R. Wright. Application for a charter will be made to the Cleveland chapter of the association.

The Oregon Society of Engineers unanimously voted at its meeting on July 24 to amalgamate with the American Association of Engineers. Other societies that expect to vote upon amalgamation in the near future are: The Engineers Club of Kansas City; the Engineers and Architects

Association of Southern California; the Southwestern Society of Engineers and the Houston Engineers Club. The question of amalgamation has been initiated by several other societies and is now under consideration by them.

Camden, (N. J.) Association No. 16, N. A. S. E., was instituted on Friday evening, Aug. 1, by State Deputy John J. Reddy, with 28 names on the charter roll. There were delegations from New York, Philadelphia and New Jersey. Mr. Reddy called the meeting to order at 9 o'clock and introduced William J. Reynolds, past national president, who fully outlined the aims and objects or the organization. State President Valentine Secor and State Vice President George Armitage of New Jersey and State Deputy Peter L. Johnson of Pennsylvania also gave interesting addresses The officers elected included William Hegarty, president; Fred Doudy, vice president; I. B. Stratton, recording secretary, Charles R Heitz, financial secretary, William R Johnson, treasurer; William J Watson, conductor; George W. Wyman, doorkeeper The board of trustees for one, two and three years, respectively, comprise Wallace Mitchell, Theodore Peterson and Charles Gravenstine. An enjoyable entertainment was furnished by Bob Jones France Packing Co., and Jack Armour, *Power*. Light refreshments were liberally served

Miscellaneous News

A new board of examining engineers for Chicago was appointed on July 21. Edward F. Moore was advanced from vice-president to president; Philip M. Gieseler was made first vice-president and Frank A. West, a member of the board.

Business Items

The Graphic Products Co., of Germantown, Philadelphia, has taken over the business heretofore conducted by the Fbre Graphite Manufacturing Co. and will continue to manufacture the latter company's products.

The Tacony Steel Co. and the Tacony Ordnance Corp., of Tacony, Philadelphia, announce the purchase of the Ordnance Corporation plant by the Tacony Steel Co. and the consolidation of the respective metallurgical and manufacturing organizations. The consolidation does not affect the officials or management, as the officers and directors have for sometime acted in the same capacity with the Steel Company and the Ordnance Corporation.

The General Gas and Electric Co. will acquire the Pennsylvania and New England properties formerly owned by the Eastern Power and Light Corporation. This acquisition is a result of plans worked out by the General Gas and Electric Company interests with the various protective committees of the Eastern Power and Light Corporation.

Trade Catalogs

Ross Heater and Manufacturing Co., Inc., Buffalo, N. Y., has just issued 17-page Catalog "C" on "Condensing Equipment with Croll-Reynolds Evactor Air Pump." Fully illustrated; two pages of tables on saturated steam included in booklet.

The Morse Chain Grate Co., Ithica, N. Y., has just issued its Publication No. 14, revised edition, on "Large Power Drives." Morse chain drives are shown as applied to 100 hp. up to 1000 hp.

The Combustion Engineering Corp., New York City, has issued a 20-page catalog, G-1, on "Grieve Grates." It shows in an interesting manner both as to text and cuts the detail operation of this type of grate. A copy may be had free upon request.

The Foxboro Co., Inc., Foxboro, Mass., has just published a finely printed 80-page bulletin, No. 104-1, on "Thermometers." The indicating dial type (regular) and recording instruments are fully described and illustrated, and specimen charts produced by multiple-pen and long distance instruments at different plants are shown. Four pages of conversion tables for Fahrenheit and Centrigrade scales complete the bulletin. A copy may be had free upon request.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7 80@7 95
Stove	7 95@8 15
Chestnut	8.05@8 35

Bituminous

	Clearfields	Cambrias and Somersets
F. o. b. mines, net tons	$2 50@3 00	$2.90@3 60
F. o. b. Philadelphia, gross tons	4 69@5 25	5.10@5 80
F o b. New York, gross tons	5 00@5.60	5.40@6.20
Alongside Boston (water coal), gross tons	6.75@7 25	6 95@7 75

Georges Creek is quoted at $3.70 per net ton, f. o. b. mines.

Pocahontas and New River are being quoted at $6 @ 6 25 per gross ton f o. b Norfolk and Newport News, Va., in response to export demand There are practically no sales for coastwise shipment.

NEW YORK—Current quotations, White Ash, per gross tons, f o.b. Tidewater, at the lower ports* are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5 95	$7 80	Pea	$5.20	$6.95
Egg	6 25	8 10	Buckwheat	3 40	5 15
Stove	6.50	8.35	Rice	2 75	4 50
Chestnut	6 60	8.45	Barley	2 25	4 00

Bituminous

	Spot
South Fork (Best)	$3.10@3.25
Cambria (Best)	2.95@3 10
Cambria (Ordinary)	2 65@2.90
Clearfield (Best)	2.95@3.10
Clearfield (Ordinary)	2 65@2 90
Reynoldsville	2.70@2.90
Quemahoning	3.10@3.25
Somerset (Best)	2.95@3.10
Somerset (Poor)	2.65@2.75
Western Maryland	2.50@2.75
Fairmont	2 10@2.35
Latrobe	2 60@2.65
Greensburg	2.50@2.60
Westmoreland ¾ in.	2 75@2.90
Westmoreland run-of-mine	2.50@2.60

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide	Anthracite	Line	Tide
Broken	$5.95	$7 80	Buckwheat	$3.40	$4.45
Egg	6.25	8.10	Rice	2.75	3.65
Stove	6 50	8 35	Boiler	2.50	3.50
Nut	6.60	8 45	Barley	2.25	3.15
Pea	5.20	6 80			

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3 25
Mine-run	2 35@ 2 50	3.00
Screenings	1 40@ 1 60	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2 45	$2.75	$2 40
Black Creek and Cahaba	3.45	3.75	3.05
Jagger - Pratt Corona	2.85	3.05	2 45
Blacksmith	...	5.25	.....

Domestic quoations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3.95@$4 60
Corona	3 50
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

	Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc)	$2 85*@3.05	$2 55	$2 25@2 50
Mine run	2 10*@2.35	2.35	1 60@1 70
Screenings	1 50*@2 20	2.05	.90@1 00

* Indicates prices on independent coal.

Williamson-Franklin rate to St. Louis is $1.07½; other rates $0 92½.

New Construction

PROPOSED WORK

Mass., Clinton—The Roubaix Mills, 792 Main St., will receive bids about August 15 for the construction of a 4 story steel and reinforced-concrete silk mill. A steam heating system will be installed in same. A. Brociner, 110 West 40th St., New York City, Engr.

Mass., Pittsfield—The South Congregational Church plans to install a new heating plant including boiler house in rear of church. Harding S. Seaver, 7 North St., Arch.

R. I., Providence—The General Fire Extinguisher Co., West Exchange St., will soon award the contract for the construction of a 4 story office building. A steam heating system will be installed in same. Total estimated cost, $150,000. Jackson, Robinson & Adams, Turks Head Bldg., Arch

N. Y., Arcade—The city has voted $100,000 bonds to build a combined grammar and high school. A steam heating system will be installed in same.

N. Y., Batavia—St. Jerome's Hospital (Sisters of Mercy) will soon receive bids for the construction of a 3 story, 40 x 75 ft. hospital. Low pressure boilers will be installed in same. Total estimated cost, $75,000.

N. Y., Buffalo—The Buffalo General Electric Co. plan to erect a brick transformer station at 385 Abbott Road. Estimated cost, $11,000.

N. Y., Long Island City—J. N. Contade, Jackson Ave. and Bridge Plaza, will soon let the contract for the construction of a 4 and 6 story, 68 x 185 ft. factory. A steam heating system will be installed in same. Total estimated cost, $300,000. Balinger & Perott, 1328 Broadway, New York City, Engr and Arch.

N. Y., Long Island City—Eggleston Bros., c/o A. G. S. Fletcher, Arch., 103 Park Ave., New York City, will soon award the contract for the construction of a 1 story, 200 x 285 ft. warehouse on School St., Borden Ave., and Mount St. A steam heating system will be installed in same.

N. Y., Mineola—The Nassau Hospital is having preliminary plans prepared for altering and building an addition to hospital here. A steam heating system will be installed in same. Total estimated cost, $300,000. Lord & Hewlet, 343 5th Ave., New York City, Arch.

N. Y., New York—The J. M. B. Realty Co., 30 East 42nd St., plans to build a 1 story, 100 x 200 ft. garage on 158th St near the tracks of the New York Central R.R. A steam heating system will be installed in same. Total estimated cost, $75,000. Gronenberg & Leachtag, 303 5th Ave., Arch.

N. Y., New York—The St. Regis Lunch Co., c/o A. Levinson, Engr., 405 Lexington Ave., will soon award the contract for the construction of a 3 story, 60 x 100 ft store and loft building at 42 West 33rd St. A steam heating system will be installed in same. Total estimated cost, $80,000.

N. Y., New York—Swift & Co., 32 10th Ave., plans to build a 10 story, refrigerating plant on West 14th St. Estimated cost, $1,000,000.

N. Y., Phoenix—The Sweet Brothers Paper Manufacturing Co. plans to install Sturtevant ventilating fans, upright engine direct connected—set of fan heaters—12 ventilating cowls and steam connections. Estimated cost, between $12,000 and $15,000. E. E. Palmer, Snow Bldg., Syracuse, Engr.

N. Y., Syracuse—The Glenside Mills Co. has purchased the factory building of the Syracuse Rug Works at 11 Tallman St. and plans to install machinery and power transmission. Estimated cost, $15,000.

N. Y., Syracuse—The congregation of St. Anthony of Padua Church, Colvin St. and Midland Ave., will soon receive bids for the construction of a 2 story, 75 x 140 ft. school. A steam heating and fan system for ventilation will be installed in same. Total estimated cost, $85,000. A. R. Acheson, 852 Ostrom Ave., Engr.

N. Y., Syracuse—The United States Hoffman Co. has purchased the Van Wie Pump Co., 709-722 West Fayette St., and will install transmission and machinery tools. Estimated cost, $25,000. J. B. Spencer, Gen. Mgr.

N. Y., Theresa—The Borden Milk Co. will rebuild its plant here, recently destroyed by fire, and will install a new boiler, engine and milk handling equipment. A. Ackerman, Theresa, Local Mgr.

N. Y., Watertown—The Board of Education will receive bids Sept. 1 for installing a heating and ventilating system in school building here, including two 80 h.p. boilers, 10,000 direct radiation—Sturtevant Blower—one set Sturtevant heaters, one 7½ h.p. electric motor, one 48 in. Sturtevant swing ventilating galvanized iron air conveyor. Estimated cost, $17,000. E. E. Palmer, Snow Bldg., Syracuse, Engr.

N. Y., Watertown—The Board of Education will receive bids Sept. 1 for installing a heating and ventilating system in school building here, including two 80 h.p. boilers, 12,000 direct radiation, Sturtevant fan and set heaters, six Sturtevant ventilating cowls, 10 h.p. electric motor galvanized iron air conveyors. Estimated cost, $20,000. E. E. Palmer, Snow Bldg., Syracuse, Engr.

N. J., Westmont—The city received bids for constructing a 9 mile sanitary sewerage system, including a pumping station, etc., from W. Penn Corson, 1141 Sycamore St., Camden, $68,416; R. F. Relly, Easton, Penn., $69,131; Pennsylvania Engineering Construction Co., 1119 North Howard St., Philadelphia, $72,597.

Pa., Erie—The Continental Rubber Co., 119th and Liberty St., will build a 2 story, 78 x 130 ft. power house. Estimated cost, $75,000. Osborn Engineering Co., 2848 Prospect Ave., Cleveland, Ohio, Engr.

Pa., Midland—The Pittsburgh Crucible Steel Co., Empire Bldg., Pittsburgh, is receiving bids for the construction of a 5 story, 50 x 180 ft. office building on Railroad Lane and 7th St. A vapor steam heating system will be installed in same. Fred I. Merrick, Empire Bldg., Pittsburgh, Arch.

Pa., Nanticoke—Nanticoke Borough plans to construct two schools, one 2 story, 25 x 40 ft. and other 2 story, 30 x 50 ft. Steam heating systems will be installed in same. Total estimated cost, $150,000. Austin Reilly, Bennett Bldg., Wilkes-Barre, Arch.

Pa., Oceola Mills—The Oceola Water Co. will receive bids August 15 for the furnishing and erecting steel elevated water tank and installing two 400 gal. capacity pumps. Total estimated cost, $15,000. Morris Knowles, Jones Law Bldg., Pittsburgh, Engr.

Pa., Philadelphia—The Department of Public Health and Charity, Room 584, City Hall, will receive bids August 18 for the completion of power house with mechanical equipment including boilers, engines, and machinery for General hospital. Total estimated cost, $250,000. P. H. Johnson, 1713 Sansome St., Engr.

Pa., Pittsburgh—The Board of Education is receiving bids for the construction of a 3 story, 225 x 250 ft. high school in the Homewood District. Steam heating and ventilating fan systems and low pressure boilers will be installed in same. Total estimated cost, $1,300,000. G. S. Orth & Bro., Jenkins Arcade, Engr.

N. C., Monroe—The city will soon receive bids for the construction of a 2 story brick school on West Lancaster St. A steam heating system will be installed in same. Total estimated cost, $50,000.

S. C., Charleston—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to install 1 turbo-alternator, Specification No. 4011, and mechanical stokers, Specification No. 4010 in the power plant here. Estimated cost, $50,000 and $11,000 respectively.

Ohio, Cleveland—The Allen Theatre Enterprises, Toronto, Ont., is having plans prepared by C. H. Crane and E. G. Kiehler, Arch., 2325 Dime Bank Bldg., Detroit, Mich., for the construction of a 6 story, theatre and office building on Euclid Ave. A complete steam heating system will be installed in same. Total estimated cost, $1,000,000.

Ohio, Cleveland—Barish & Bingham Co., 10601 Madison Ave., plans to build a 2 story, 39 x 123 ft. office addition. A steam heating system will be installed in same. Total estimated cost, $75,000.

Ohio, Cleveland—The Cleveland Worsted Mills Co., 6300 Broadway Ave., will install a steam heating system in the 10 story, 89 x 105 ft. warehouse which it plans to build at 5442 Blanche Ave. Total estimated cost, $400,000.

Ohio, Cleveland—The Colburn Machine Tool Co., 1040 Ivanhoe Rd., will install a steam heating system in the 1 story, 44 x 78 ft. office building which it plans to construct. Total estimated cost, $80,000.

Ohio, Cleveland—Company c/o Citizens Savings & Trust Co., Citizens Bldg., plans to construct a 5 story, 270 x 280 ft. commercial building on East 30th St. and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ohio, Cleveland—The Glidden Varnish Co., Madison Ave. and Berea Rd., is having plans prepared for a 4 story, 59 x 90 ft. grinding building on Madison Ave. A steam heating system will be installed in same. Total estimated cost, $60,000. Osborn Engineering Co., 2848 Prospect Ave., Engr.

Ohio, Cleveland—Hoffman Bros., Electric Bldg., will install a steam heating system in the 4 story, 101 x 164 ft. theatre which they plan to build at 10210 Euclid Ave. Total estimated cost, $250,000.

Ohio, Cleveland—Henry O. Oster, 2052 East 105th St., plans to construct a 42 x 280 ft. commercial building addition at East 105th and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—A. Teachout Co., 321 Prospect Ave., N. W., plans to construct a 3 story, 100 x 160 ft. lumber mill on West 20th St. and Lorain Ave. A steam heating system will be installed in same. Total estimated cost, $80,000.

Ohio, Cleveland — D. R. Hanna, 511 Leader-News Bldg., plans to construct a 11 story, 100 x 192 ft. theatre on East 14th St. and Prospect Ave. A steam heating system will be installed in same. Total estimated cost, $750,000. C. A. Platt, 101 Park Ave., New York City, Engr.

Ohio, Dayton—The Hollywood Club, 133 West 2nd St., plans to build a 3 story, 60 x 130 ft. clubhouse. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Newark—Bodenstein & Surmann, Arch., 2nd National Bank Bldg., Cincinnati, are receiving bids for the construction of a 2 story, 30 x 60 ft. power house, for W. S. Weldand & Son. Estimated cost, $35,000.

Ohio, South Euclid—Board of Education plans to build a 1 story, 75 x 150 ft. school. A steam heating system will be installed in same. Total estimated cost, $150,000.

Mich., Allegan—The Overton Creamery Co. is having plans prepared by the McCormick Co., Arch. and Engr., Century Bldg., Pittsburgh, Penn., for the construction of a creamery and dairy, including a 40 x 50 ft. power house in which four 150 h.p. boilers will be installed. Total estimated cost, $100,000.

Mich., Detroit—The Allen Theatre Enterprise, c/o F. G. Kiehler, Arch., 2325 Dime Bank Bldg., Detroit, had plans prepared for the construction of a 2 story, 133 x 200 ft. theatre and store building on Woodward Ave. and Watson St. A steam heating plant, fans, vacuum pump motor, etc., will be installed in same. Total estimated cost, $600,000.

Mich., Detroit—The Belle Isle East Side Creamery Co., 1020 Forest Ave., E., plans to build a 2 story, 45 x 100 ft. addition to its creamery. A steam heating system and electric motors will be installed in same. Total estimated cost, $40,000. Williams Bros., 1111 Kresge Bldg., Arch.

Mich., Detroit—C. H. Crane and E. G. Kiehler, Arch., 2325 Dime Bank Bldg., are preparing plans for the construction of a 2 story, 50 x 200 ft. theatre on Michigan Ave. and Chopin St., for Anthony G. Grzezinslki, 1518 Michigan Ave. A steam heating system, fan and motor will be installed in same. Total estimated cost, $50,000.

Mich., Detroit—A. Harvey's Sons Manufacturing Co., First St., plans to build a 2 story, 60 x 100 ft. foundry on Bellevue Ave. and Michigan Central Ry. A steam heating system will be installed in same. Smith, Hinchman & Grylls, Washington Arcade, Arch.

Mich., Detroit—The Ionic Lodge F. & A. M., Lawton and Grand River Ave., is having plans prepared for the construction of a 3 story, 90 x 100 ft. temple on Grand River Ave. A steam heating and ventilating system will be installed in same. Total estimated cost, $130,000. G. W. Graves, 43 John River St., Arch.

Mich., Detroit—The Moore Realty Co., 512 Holden Bldg., plans to construct a 2 story, 75 x 100 ft. mercantile building on Grand River Ave. near Vinewood St. A steam heating system will be installed in same. Total estimated cost, $100,000. R. Arthur Bailey, 54 Lafayette Ave., Arch.

Mich., Detroit—B. C. Wetzel & Co., Arch., 2317 Dime Bank Bldg., is preparing plans for the construction of a 2 story, 95 x 200 ft. commercial building and hall on Woodward Ave. and Watson St. Steam heating equipment including a boiler, vacuum pump and accessories will be installed in same. Total estimated cost, $150,000. Owner's name withheld.

Mich., Detroit—Zemon & Wetsman, 1020 Chamber of Commerce, plans to build a 2 story theatre, bank and store building on Linwood Ave. and Virginia Park. A steam heating system will be installed in same. Total estimated cost, $150,000. G. V. Pottle, 1401 David Whitney Bldg., Arch.

Mich., Ecorse—St. Francis Parish plans to build a 2 story, 80 x 150 ft. school on State and Webster St., and will install a steam heating system; also boiler, vacuum pump and motor and fans for ventilation. Total estimated cost, $150,000. G. W. Graves, 43 John R. St., Detroit, Arch.

Mich., Holly—Holly Lodge F. & A. M. is having plans prepared for the construction of a 3 story, 63 x 108 ft. temple on Main St. Steam heating equipment, including a boiler and pump will be installed in same. Total estimated cost, $100,000. G. W. Graves, 43 John R. St., Detroit, Arch.

Mich., Houghton—The Good Will Farm will soon award the contract for the construction of a 2 story, 83 x 134 ft. home. A steam heating system will be installed in same. Total estimated cost, $100,000. Maas Bros., 400 Penobscot Bldg., Detroit, Arch.

Mich., Marysville—Wills & Lee, Book Bldg., Detroit, are having plans prepared by Smith, Hinchman & Grylls, Arch., 710 Washington Arcade, Detroit, for the construction of an automobile factory along the St. Clair river. A power plant will be part of the proposed construction.

Mich., Negaunee—St. Paul's Parish house will soon award the contract for the construction of a church, school and parish house. A steam heating system will be installed in same. Total estimated cost, $150,000. Van Leyen, Schilling & Keough, 1115 Union Trust Bldg., Detroit, Arch.

Ill., Bellville—The St. Clair National Bank Co., c/o William Reichert, Freeburg, plans to build a bank here. A steam heating system will be installed in same. Total estimated cost, $150,000.

Ill., Chicago—Holabird & Roche, Arch., 104 South Michigan Ave., are receiving bids for the construction of a 19 story, 85 x 190 ft. hotel, at 177 West Madison Ave., for the Blackhawk Hotel Co., c/o architects. A steam heating system will be installed insame. Total estimated cost, $1,250,000.

Ill., Chicago—The Madison & Ketzie Bank, 3131 Madison St., plans to construct a 2 story, 100 x 120 ft. bank on Madison & Ketzie Ave. A steam heating system will be installed in same. Total estimated cost, $325,000. J. K. Cady, 179 West Washington St., Arch.

Ill., Chicago—W. G. Shedd, c/o A. S. Alachuler, Arch., 28 East Jackson St., will soon receive bids for the construction of a 12 story, 75 x 125 ft. office building on Wabash and Harrison Ave. A steam heating system will be installed in same. Total estimated cost, $1,300,000.

Wis., Bloomington—The Board of Education c/o City Clerk, will install a steam heating or hot water heating system in the 4 story, 90 x 150 ft. high school which it plans to build on Main St. Total estimated cost, $75,000.

Wis., Hartford—The city will receive bids Aug. 15 for furnishing 2 new boilers of 400 h.p. each and 3 boilers of 250 h.p. each. Estimated cost, $15,000. W. Rodke, City Clk.

Wis., Neenah—The First National Bank is having plans prepared for a 1 story, 41 x 84 ft. bank. A steam heating system will be installed in same. Total estimated cost, $100,000. Childs & Smith, 64 Van Buren St., Chicago, Arch.

Wis., Two Rivers—The Hamilton Manufacturing Co. will soon award the contract for the installation of an electric fire pump, service pump and bilge pump in power house here. Total estimated cost, $20,000. Lock & Green Co., Chicago, Engr.

Kan., Fort Dodge—The State will soon award the contract for the construction of a 2 story, 67 x 166 ft. Soldiers' Home. A steam heating system will be installed in same. Total estimated cost, $75,000. R. S. Gamble, Topeka, State Arch.

Kan., Marion—Marion County is having plans prepared by Tonini & Bramblet, 417 Terminal Bldg., Oklahoma, Okla., for the construction of a 3 story, 96 x 124 ft. courthouse. A steam heating system will be installed in same. Total estimated cost, $300,000.

Mont., Helena—The Algeria Patrol Shrine will soon receive bids for the construction of a 1 story temple, which it plans to build on Neil and Benton Ave. A steam heating system will be installed. Total estimated cost, $200,000. S. S. Haire and C. H. Carsley, Power Bldg., Arch.

Mont., Scobey—The city will soon award the contract for improving the waterworks, including the installation of a 300 gal. per minute and a 15 gal. per minute centrifugal pump and 40 p. semi Diesel engine. Total estimated cost, $85,000. W. B. Saunders, Helena, Engr.

Mo., Cameron—The city will soon award the contract for the construction of a 160,000 gal. filtration plant and will install motor-driven centrifugal pump, etc. E. E. Harper, 2408 East 30th St., Kansas City, Engr.

Mo., Carthage—The Platt-Porter Wholesale Grocery Co. is having plans prepared by Perry K. Simpson, Arch., Carthage, for the construction of a 2 story, 50 x 160 ft. wholesale grocery house on 6th and Main St. A steam heating system will be installed in same. Total estimated cost, $55,000.

Wash., Aberdeen—The Pantages Amusement Co. plans to construct a 4 story theatre and office building on I and Wishah St. A steam heating system will be installed in same. Total estimated cost, $175,000.

Ore., Astoria—Jensen & Von Herberg, Portland, owners of the Columbia and Liberty theatres, have purchased a site here and plans to build a 3 story, 100 x 166 ft. theatre. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ore., Pendleton—School District No. 117, R. F. D., No. 1, plans to install 700 gal. per hour pumping and vapor heating system. Estimated cost, $5000. G. R. Wright, 614 Main St., Arch.

Cal., Chico—The City Trustees have directed F. S. Robinson, City Engr., to make a preliminary survey and submit estimate for power plant in Chico Creek to develop 3000 h.p.

Cal., Copperopolis—The Calaveras Copper Co. is having plans prepared for the construction of a reservoir and power plant.

Cal., Los Angeles—The Albertson Motor Car Co. is having plans prepared for the construction of a 2 story, 155 x 160 ft. auto sales building on 16th and Figueroa St. A steam heating system will be installed in same. L. A. Smith, 621 Investment Bldg., Arch.

Ont., London—Marcus Loew, 1492 Broadway, New York City, will receive bids until Aug. 11, for the construction of a 1 story, 100 x 125 ft. brick and steel theatre. A steam heating system will be installed in same. Total estimated cost, $200,000. T. W. Lamb, 644 8th Ave., New York City, Arch.

Ont., Ottawa—Allen W. Horwood, Arch., Castle Bldg., Queen St., is receiving bids for the construction of a 3 story, 60 x 100 ft. store building on George St., for A. J. Freiman, Rideau St. A steam heating system will be installed in same. Total estimated cost, $80,000.

Ont., Ottawa—Loew's Theatre, 1492 Broadway, New York City, will soon award the contract for the construction of a 2 story, 100 x 175 ft. theatre. A steam heating system will be installed in same. Total estimated cost, $300,000. T. W. Lamb, 644 8th Ave., New York City, Arch.

Ont., Strathroy—Dominion Canners, Aylmer, will soon award the contract for the construction of a canning factory, here, to include a process room, boiler, engine house and storage building. Total estimated cost, $75,000. T. Wooster, Aylmer, Arch.

Ont., Thorold—The Ontario Paper Co. will purchase transmission and drive machinery to replace same damaged in recent fire. Estimated cost, $5000.

Sask., Moose Jaw—The city plans to install a Diesel engine and pump in connection with proposed waterworks system. Estimated cost, $148,000.

CONTRACT AWARDED

Mass., Boston—The Upson Paper Co., Upson Point, Lockport, N. Y., has awarded the contract for the construction of a new mill, to the Aberthaw Construction Co., 27 School St. Plans include an engine and boiler room, etc. Total estimated cost, between $250,000 and $300,000.

R. I., Crompton—The Crompton Co. has awarded the contract for the construction of a 2 story, 110 x 200 ft. addition to its mill, to J. F. McCusher, Phenix. A steam heating system will be installed in same. Total estimated cost, $125,000.

R. I., Pawtucket—J. W. Little Co., Exchange St., has awarded the contract for the construction of a 2 story printing plant to F. G. Rowley Co., 260 Central Ave. A steam heating system will be installed in same. Total estimated cost, $40,000.

N. Y., Binghamton—The Kodeco Co. here awarded the contract for the construction of a 62 x 133 ft. reinforced concrete and brick theatre at 29 Chinango St., to A. E. Badgley, Binghamton. A steam heating system will be installed in same. Total estimated cost, $100,000.

N. Y., Black River—The Northern New York Utilities Co., 58 Public Sq., Watertown, has awarded the contract for the construction of a power dam and 2450 ft. power canal to Burns Brothers & Haley, Watertown; construction of a reinforced concrete power house for installation of three 3000 h.p. generating units, to the Walsh Construction Co., Davenport, Iowa. Total estimated cost, $600,000. Electric equipment will be furnished by the General Electric Co., River Rd., Schenectady, and hydraulic equipment by S. Morgan Smith Co., York, Pa. Noted June 24.

N. J., Jersey City—The Board of Education has let contract for installing exhaust fan and electrical equipment in the Lincoln High School, to Walter Coleman, Willow Court. Estimated cost, $10,000.

Penn., Philadelphia—The Vigogne Mills, Adams Ave. and Wingohocking St., has awarded the contract for the construction of a 3 story, 63 x 250 ft. factory on Unity and Oakland St., to M. Ward Easly, 1420 Chestnut St. Bids will soon be received for a steam heating system in same. Total estimated cost, $100,000. Noted July 15.

Ohio, Cleveland—J. M. & L. A. Osborn Co., Superior Viaduct, has awarded the contract for the construction of a 2 story, 130 x 150 ft. warehouse on East 39th St. and Superior Ave., to Sam W. Emerson Co., 1900 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $300,000. Noted April 15.

Ohio, Euclid—The Cleveland Heights Board of Education has awarded the contract for the construction of a 2 story, 75 x 100 ft. high school in Euclid Village, to Kelley Demarest Construction Co., American Trust Bldg., Cleveland. A steam heating system will be installed in same. Total estimated cost, $100,000. Noted July 8.

Ohio, Lorain—T. C. Metzer, Broadway Ave., has awarded the contract for the construction of a 5 story, 70 x 140 ft. hotel, to Crowell Lundoff Little Co., Meriam Bldg., Cleveland. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ohio, Middletown—The American Rolling Mills Co. has awarded the contract for the construction of an extension to its sheet and jobbing mill plant, to Westinghouse Church, Kerr & Co., 37 Wall St., New York City. A steam heating system will be installed in same. Total estimated cost, $2,000,000.

Mich., Detroit—The Commerce Motor Car Co., Solvay and Mackie Ave., has awarded the contract for the construction of a 1 story, 120 x 240 ft. auto truck factory, to L. W. Zander, 708 14th St. A steam heating system and electric motors will be installed in same.

Mich., Detroit—Myles Standish, 39 Pingree Ave., has awarded the contract for the construction of a 3 story, 60 x 150 ft. garage on Woodward and Hancock Ave., to John Finn & Son, 2375 Woodward Ave. A steam heating system will be installed in same. Total estimated cost, $65,000.

Mich., Redford—St. Mary's Parish has awarded the contract for the construction of a 2 story, 80 x 160 ft. school, to John Finn & Son, 2375 Woodward Ave, Detroit. A steam heating system will be installed in same. Total esimated cost, $150,000.

Ill., Chicago—Albert Pick & Co., 212 West Randolph St., has awarded the contract for the construction of a 5 story warehouse on 35th St. and Racine Ave., to E. W. Sproul Co., 2001 West 39th St. A steam heating system will be installed in same. Total estimated cost, $400,000.

Ill., Chicago—The Cleveland Metal Products Co., Platt Ave., Cleveland, has awarded the contract for the construction of a 3 story, 90 x 200 ft. warehouse on West 43rd St. and Western Ave., to the Austin Co., 208 South La Salle St. A steam heating system will be installed in same. Total estimated cost, $150,000.

Ill., Chicago—The Commonwealth Edison Co., 72 West Adams St., has awarded the contract to the Black Construction Co., 20 West Jackson St., for the construction of two 2 story, 40 x 84 ft. concrete and brick transformer stations, one at 6909 Throop St. and other at 2644 Irving Park Blvd., each to contain 3 transformers of 4000 k.w. capacity. Total estimated cost, $175,000.

Ill., Chicago—St. Philip Benici Catholic congregation, Oak and Cambridge St., has awarded the contract for the construction of a 2 story, 60 x 105 ft. school, to F. Burke, 35 South Dearborn St. A steam heating system will be installed in same. Total estimated cost, $75,000.

Have You a Business "Want"?

No matter what it is, the Searchlight Section can help you.
It is the "opportunity" section of this paper.

You may be interested in some of the announcements in this issue. Turn to pages 81 to 89

FOR EVERY "WANT"

Think "SEARCHLIGHT" First

POWER

Volume 50 New York, August 19, 1919 *Number* 8

James Watt

By Rufus T. Strohm

His was the dauntless faith, the vision clear and certain,
That made sublimely real the substance of a dream;
His was the daring hand that swept aside the curtain,
Revealing to his fellows the potency of steam.
Then Earth began to pour in swiftly growing measures
The metals from her mountains, the fuel from her mines,
To meet the needs of men and multiply their pleasures
And mold their weak achievements in mightier designs.

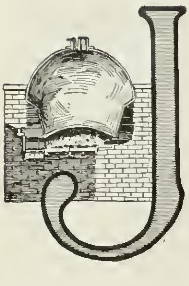
He blazed a virgin trail for other feet to follow,
And slow-paced human progress sped on a thousand years;
For railroads flung their bands o'er every hill and hollow
To link with teeming cities the uttermost frontiers;
While vessels staunch and trim, the fickle winds disdaining,
Went weaving foaming wakes where restless oceans roll,
Their pennoncels of smoke and plumes of vapor staining
The vaulted dome of heaven from distant pole to pole.

His genius unlocked the barred and bolted prison
That held in age-long fetters the giant, Industry,
And factories and mills with magic speed have risen
In numbers that outrival the rocks that ring the sea,
While myriad machines of intricate devising
Receive the million products of forest, mine and mart
And fashion them with skill and energy surprising
For every need of warfare and every peaceful art.

A century has passed while his brave soul lay sleeping
Where Handsworth's parish church uprears its ivied walls,
But though the grave may hold his dust within its keeping,
His spirit lives wherever a chimney's shadow falls.
The roar of mighty engines, above the workshop's clamor,
The whir of driven pulleys, the growl of gnashing gears,
The deep-toned clang of steel beneath the beating hammer
Must fall like pleasant music upon his ghostly ears.

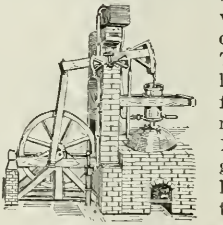
James Watt

By C. H. Bromley



JAMES WATT is dead one hundred years today, August 19. No man in all history, perhaps, has exerted greater influence upon industrial civilization—aye, upon all civilization. One need reflect but a moment to appreciate that without steam power we would today be living in an age of baron and serf, with agriculture the main pursuit of all peoples, with woeful illiteracy and hard, hand labor for all who labored, with crude, slow transportation, likely without the development and use of electricity and refrigeration.

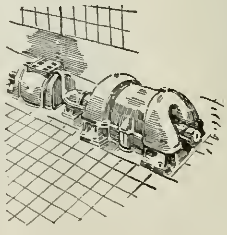
Studying steam-engine development prior to, contemporaneous with and succeeding Watt, in the light of the foreign policy and commercial activity of England seems to warrant a belief that the steam engine was a most powerful factor in the rapidly rising superiority of England in the world's commerce. Before the introduction of the steam engine England had acquired world dominance by sea power. The last great naval force mobilized for the invasion of England was the famous Spanish Armada, which Drake destroyed in 1588. But this was before the steam engine. During the frequent wars between France and Spain, which lasted from the Thirteenth Century until the complete disintegration of Spain as a world power, the English were taking advantage of every factor in world commerce control. Yet every people of war-ridden Europe were suffering great privations, just as they are now. At this time came the steam engine like a God-given gift to multiply many times the productive power of the Island Kingdom, to make profitable the working of abandoned coal mines—in short, to make England the savior of the world as far as commodities go, just as our food and other commodities saved the cause of civilization in this war. England ruled the sea and so with expediency and dispatch carried her commodities to the four corners of the earth. Some years later, America, great in world sea commerce, scoffed at the steam-propelled ship, while England, appreciating its superiority over the sail, built great fleets which, up until now, have practically swept America from the seas.



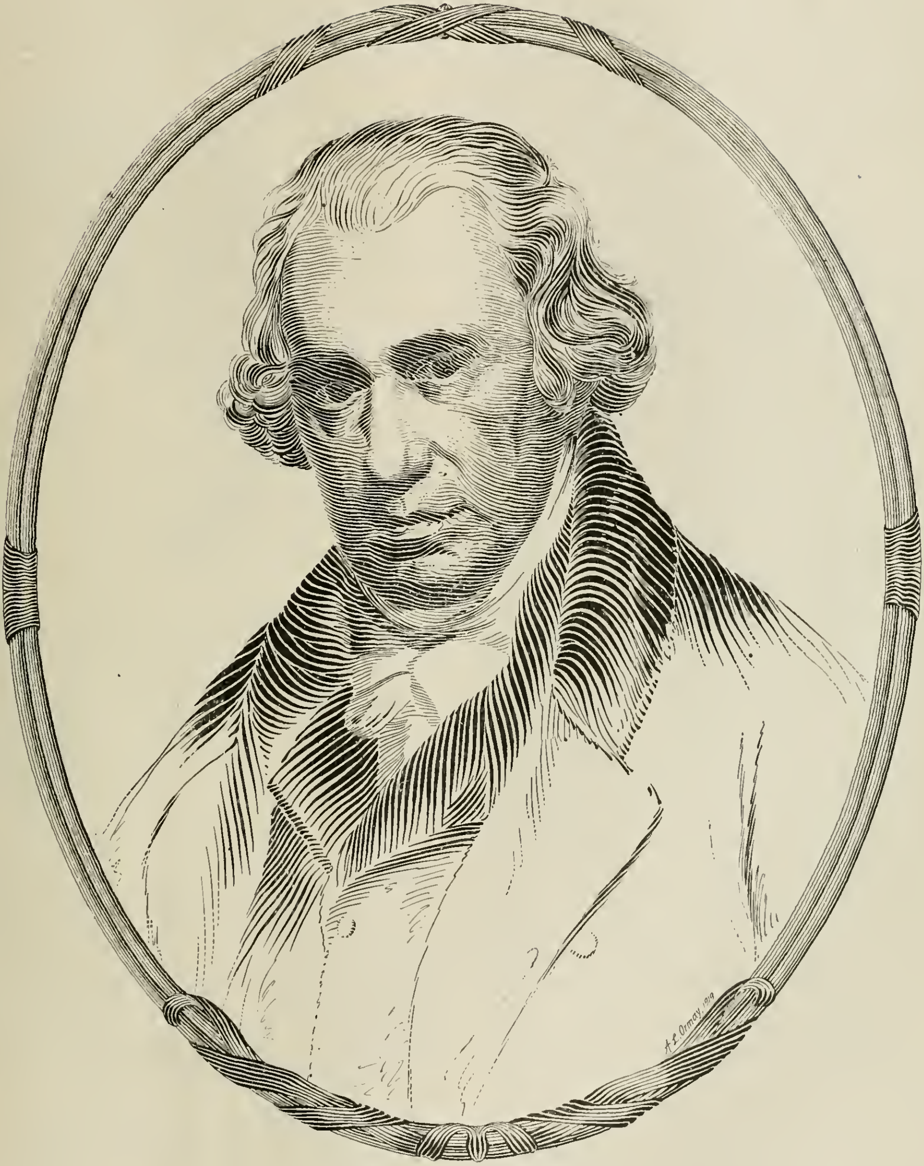
In these days of great labor unrest it is of interest to recall the effect of the steam engine upon labor. From 1811 to 1816 severe riots occurred at Nottingham, Yorkshire, Lancashire, Derbyshire and Leicestershire among the working people because they feared the steam engine would bring misery due to the change from hand to machine work which it was bringing about. These rioters were known as the Laddites.

Men, like things, are composites of what has gone before—they are what their ancestors and the arts have made them. So, too, with Watt. To know him we must know what he was and what physical science was when he began to utilize natural laws. Watt was born at Greenock, Scotland, Jan. 19, 1736, the son of a small merchant. At 19 he went to London to learn the trade of "philosophical instrument maker." Now leave him and pick up the thread of physical discoveries and inventions long before his time. Galileo, famous in astronomical and ecclesiastical history, suspects the existence of atmospheric pressure in 1640. In 1643 Torricelli, his student, proves Galileo was right and demonstrates atmospheric pressure. It was by atmospheric pressure that early steam engines were operated. The Marquis of Worcester in 1663 made a steam engine in which steam was expanded to force up water in a jet. Captain Savery made a pump in 1699 in which he employed the principles of expansion and condensation of steam. Newcomen made himself immortal by greatly perfecting the idea of Papin in 1710, making a type of pumping engine which was the most valuable engine commercially ever invented. Newcomen had the advantage of many minds, for in 1663 the Royal Society with such men as Sir Isaac Newton, Boyle, Dr. Hooke, Dr. Wallis and others, was formed for the promotion of physical science. Newcomen derived especial benefits from the work of Denys Papin, a French physician, who became a member of the Royal Society in 1680 and for ten years devoted his life to the physics of fluids. He was the first to raise a piston in a cylinder by means of vapor and atmospheric pressure—a principle which is basic in the reciprocating steam engines and even turbines of today. Then there was the notable work written by Solomon De Caus in 1623 on the use of nature's forces in machines. The foregoing are some of the chief problems that Watt found already worked out for him when, as philosophical-instrument maker to the University of Glasgow, in 1764, he was given a small Newcomen engine to repair. Here in the quiet of his laboratory, while he was tinkering with this "job," were to develop the ideas which were to commercialize steam power and revolutionize civilization.

He found soon that the steam consumption of Newcomen's engine could be greatly decreased by keeping the cylinder as hot as the steam used in it and keeping the condensed steam at 100 deg. F. or lower. But the properties of steam were not known. Dr. Cullen had found that water in a vacuum boiled at a lower temperature than at atmospheric pressure. So with this knowledge, supplemented by his own researches, Watt found out much about the properties of steam, and his work was the most authoritative of his time. He saw that the losses occasioned by initial condensation could to a great degree be overcome by creating a vacuum for the engine in a separate vessel connected to the engine by a pipe and by jacketing the engine cylinder. So he invented the jet condenser.



Jan. 5, 1769, Watt took out his first patent on the steam engine. He then went in business with John Roebuck, owner of the Carron Iron Works. Roebuck failed and Watt temporarily gave



James Watt
1736–1819

up steam engineering and did civil engineering for the Crown. When his patent had nearly expired, he met Matthew Bolton, of the Soho Works, and together by act of Parliament they got the patent extended for 25 more years. This was in 1775. Now his work began in earnest. In 1782 he introduced expansive force of steam to a piston instead of merely using steam to fill a cylinder, displace the air and then condense the steam so atmospheric pressure would drive it. This was a big and bold step. Then quickly came the throttle valve, cutoff, engine indicator and centrifugal governor.

Others were quick to appreciate and take advantage of the possibilities of steam pressures above atmospheric, a field initiated by Watt, but not carried far by him. In fact, Watt was hostile toward "high steam pressures." Trevithick, a contemporary of Watt, wanted to use a pressure of something like 40 lb. gage, and Watt, either because he believed it dangerous or because of purely commercial reasons, took the matter to Parliament, whose authority he invoked to suppress the use of such a dangerous pressure.

Naturally, with the realization that these so-called high pressures were practicable, engineering saw the value of compounding, and Wolf in 1805 brought out a compound engine. This also brought protests from Watt.

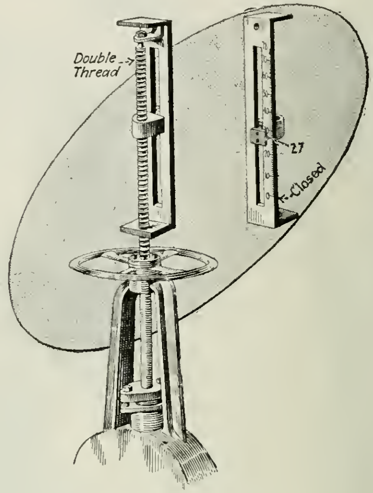
Watt may have really believed these two great advances were dangerous. But if one has in mind that Watt was the greatest engineer of his time, that he knew the properties of steam perhaps better than any other man, that he and Bolton were taking as payment, or at least part payment for their engines, the savings they effected over the Newcomen pumping engines then in use, one becomes convinced that it was competitive, more than scientific reasons, which made Watt hostile to further increase in pressures and to compounding. It was in 1784 that Watt succeeded in adapting the piston to produce continuous circular motion of a shaft. Then, of course, the steam engine became applicable to all industry, whereas previously it had found application solely to pumping water from flooded and abandoned coal mines. It is, therefore, reasonable to suppose that Bolton and Watt did not want more competition or engines of greater economies than their make offered to the many large industries which needed the steam engine.

In Manchester in 1824 there were about 240 "large" steam engines, each of about 15 to 20 hp. There is now operating in the Seventy-fourth Street Station of the Interborough Rapid Transit Co., New York City, a 60,000-kw. turbine. Watt's early engines required about 9 lb. of Newcastle coal per horsepower-hour. Modern turbines require but a pound.

It is 150 years since Watt patented his first engine, but considering the high state to which he had perfected it before he died, one may say that, commercially, no other great era in steam engineering came until 133 years later, when in 1902 large—for that time—steam turbines were successfully applied at Hartford, Conn. The writer does not forget Porter, Corliss, Sweet, Leavitt, Reynolds, and others; their work marked great improvements, but ushered in no new type of prime mover nor changed extensively the fundamental type completed by Watt. It is unfortunate that lack of space forbids reviewing, generally, the progress in steam-boiler practice in the same period, for here, too, great strides have been made which have added materially to the improved performance of steam-power plants.

Injection-Water-Valve Gage

Engineers recognize the value of knowing how much the injection-water valve is open. Numerous devices have been used for this purpose, and the accompanying illustration shows a rig one engineer designed and used. Attached to the top of the valve handwheel is a flange in which is screwed a double-threaded stem and which is steadied at the top by an angle-iron bearing. In front of the screw is a gage board slotted so that a marker can slide from the top to the bottom, as shown in the illustration. Where this rig was used, it requires 78 turns of the handwheel to open the valve wide. The running position at the time the sketch was made was 28 turns. The general arrangement is shown, and the gage board can be secured either to the valve proper or to an overhead source. The value of the arrangement is obvious.



VALVE-OPENING INDICATOR

Delegates to the Convention, National Association of Stationary Engineers

Power will again this year try to publish the photos of attending delegates in its convention fun maker, the *Power Pup*. Also each delegate will be given a package of cards bearing his photograph, name, position, association and city. But to do this we must have either your photograph or the electrotype we gave you at previous conventions, together with name, position, association and city.

All photographs must be of post-card size and show only head and shoulders—the three for a quarter kind will do. No photos will be accepted at Huntington, as Huntington affords no facilities for making electrotypes.

Please call this to the attention of your fellow-delegates and mail your photograph or electrotype today. These cards will help you to associate the names with the faces of the many new friends you will make. Address, Editor of *Power*, Tenth Avenue at Thirty-sixth Street, New York City.

Pulverized Coal as a Fuel*

By N. C. HARRISON

The author first reviews some of the uses of pulverized coal in the industries, such as the cement, steel and copper industries. The use of pulverized coal in stationary boiler plants is discussed, five determining factors in the successful operation of such a plant being taken up in detail. As compared with mechanical-stoker plants the advantages of the pulverized-coal plant are enumerated and certain precautions to be observed with the latter type of plant are brought out. A report of a test of a 468-hp. Edge Moor boiler with pulverized-coal equipment is included in the paper and the efficiency obtained is compared with the efficiency of a stoker-fed boiler in the same plant, a greater net efficiency being found in the pulverized-coal plant.

PULVERIZED coal was first used in the United States about 26 years ago for the economical burning of the cement rock in the rotary kilns of the portland-cement industry. Somewhere between 30 and 50 million tons of pulverized coal have been used to date in the manufacture of cement alone. There is now being used approximately 6 million tons annually. A total of approximately ten million tons of pulverized coal is burned annually in the United States in industries.

Generally speaking, coals which would give the most satisfactory results would be those in which the ash content would be less than 10 per cent., the volatile averaging between 30 and 40 per cent. and the fixed carbon between 40 and 50 per cent. The sulphur content should be low, although coal with a sulphur content running as high as 4½ to 5 per cent. is being burned in pulverized form under boilers without any detrimental results. The ash should have a high melting point. These statements, however, are tentative, as excellent results have been obtained from all sorts of coals, differing widely from the ideal analysis stated.

From Texas to Edmonton, Alberta, the country is underlaid with various grades of lignites, low-grade mineral coals with high moisture content and of such a nature that the ash would melt or flow down on the grates, thereby preventing the highest efficiency from being obtained. They are of such a nature that their use in gas producers is not very satisfactory, so that until the development and burning of these coals in pulverized form was an assured success they were not used in as large quantities as is now possible.

Coal must be pulverized so that at least 95 per cent. will pass through a 100-mesh sieve having 10,000 openings to the square inch, or in terms of dimension 95 per cent. must be less than one two-hundredth of an inch cube.

A cubic inch of coal pulverized so that 95 per cent. will pass through a 100-mesh sieve will contain over 200 million particles, none of which will be greater than one one-hundredth of an inch cube, and a large percentage will be less than one six-hundredth of an inch cube. A cubic inch of coal has a superficial area of 6 sq.in., but the combined area of these multitudes of small particles shows that when the coal is ground to above-mentioned degree of fineness the superficial area will increase to nearly 30 sq.ft., or an increase in area of approximately 700 times. This increase in area permits perfect and instantaneous combustion. Its rapidity depends directly upon the surface exposure. This is one of the reasons for the grinding.

Costs of Pulverizing Coal

The cost of the operation of pulverizing coal depends upon four items: First, the amount of moisture that must be expelled from the coal before pulverizing; second, the cost of labor; third, the cost of coal delivered at the pulverizing plant; fourth, the cost of electricity. Table I, issued by a pulverized-coal engineering company, gives the cost of pulverizing plants, including buildings, and costs of pulverizing coal in plants of capacity from 10 to 250 tons per day. These figures include all costs, except interest and depreciation, in the pulverizing plant proper.

TABLE I. COSTS OF COAL-PULVERIZING PLANTS AND COSTS OF PULVERIZING COAL PER TON NET

Tons Daily	Total Cost Pulverizing per Ton	Cost of Plant Including Building	Labor, Hours	Labor, Cost per Ton
10	$0.56	$31,000	10	$0.30
20	.51	31,000	20	.25
30	.49	31,000	30	.23
40	.49	31,000	40	.23
50	.39	37,000	26	.13
60	.39	37,000	30	.13
70	.39	37,000	40	.13
80	.39	37,000	40	.13
90	.39	37,000	46	.13
100	.34	45,000	34	.09
110	.34	45,000	37	.09
120	.33	45,000	40	.08
130	.33	45,000	44	.08
140	.32	50,000	45	.06
150	.32	50,000	47	.06
160	.32	50,000	50	.06
170	.32	50,000	54	.06
180	.32	50,000	57	.06
190	.30	62,000	48	.04
200	.30	62,000	51	.04
210	.30	62,000	53	.04
220	.30	62,000	56	.04
230	.30	62,000	59	.04
240	.30	62,000	61	.04
250	.30	62,000	63	.04

The data on which Table I is based are as follows:

Labor rate: Millers, 30c. per hour; drier firemen, 20c. per hour; common labor, 20c.

Cost of drier fuel: 6c. per net ton, based on 7 per cent. moisture. Coal at $5 per ton delivered.

Evaporation: 6 lb. per lb. of coal burned or 26 lb. of coal per ton.

Repairs: 7c. per net ton. This includes whole pulverizing plant, all machinery.

Power has been based on 12.7c. per ton pulverized, and a consumption of 17 hp.-hr. per ton pulverized at 1c. per kw.-hr. or about $54 per hp. per annum.

We have taken from Table I figures relating to those plants having daily capacities approximately the same as our plant, and by changing labor rates to correspond to our rates have recomputed these figures as given in Table II.

TABLE II COST OF PULVERIZED COAL PER TON NET

Tons Daily	Total Cost Pulverizing per Ton	Labor, Hours	Labor Cost, per Ton
80	$0 45	40	$0.19
90	.45	46	.19
100	.38	34	.13

Data on which table II is based:

Labor rate: Millers, 40c. per hour; drier firemen, 35c. per hour; common labor, 35c.

Cost of drier fuel: 6c. per net ton, based on 7 per cent. moisture. Coal at $5 per ton delivered.

Evaporation: 6 lb. per pound of coal burned or 26 lb. of coal per ton.

Repairs: 7c. per net ton; this includes whole pulverizing plant, all machinery.

Power has been based on 12.7c. per ton pulverized, and a consumption of 17 hp.-hr. per ton pulverized at 1c. per kw.-hr.

Cost of pulverizing will naturally vary according to local conditions.

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*Abstract of a paper presented at the Spring Meeting of the American Society of Mechanical Engineers, Detroit, Mich., June, 1919.

Table III shows actual costs at our plant, and these are slightly higher than figures given in Table II.

TABLE III. COSTS OF PULVERIZING COAL PER NET TON AT THE ATLANTIC STEEL COMPANY

		Cost per ton
Daily Output 80 Tons per Day		
Labor		$0.22
Repairs		19
Power		134
Drier coal		.0218
Total cost		$0.5658
Daily Output 90 Tons per Day		
Labor		$0.195
Repairs		.19
Power		.134
Drier coal		0218
Total cost		$0.5408
Daily Output 100 Tons per Day		
Labor		$0.176
Repairs		19
Power		134
Drier coal		.0218
Total cost		$0.5218
Total coal pulverized Jan. and Feb., 1919		5275 tons
Power: 17.9 kw.-hr. per ton coal pulv. at ¾ cent		$0.134 per ton
Labor: 1 man 16 hours at $0.40	$6.40	
2 men 16 hours at $0.35	11.20	
Daily cost	$17.60	

(= $0.22 for 80 tons output, $0.195 for 90 tons, $0.176 for 100 tons.)

Drier coal: Cost of drier fuel 2.8c. per ton, based on 2.62 per cent. moisture. Coal at $5 per ton, 6 lb. evaporated per lb. of coal burned or 8.7 lb. per ton of coal pulverized

Repairs: Total repairs for Jan. and Feb	$1412.16	
Credit	409.69	
Charged	$1002.47	(= $0.19 per ton pulv.)

For the proper combustion of coal under boilers, there are five main points which must be given serious consideration, otherwise the burning of this fuel will not be a success: Coal fineness, size of combustion chamber, necessary air opening, proper damper regulation, clean tubes.

The pulverized coal should run about 96 per cent. through the 100-mesh screen and about 85 per cent. through the 200-mesh screen. If it runs below 80 per cent. through the 200-mesh screen, we notice particles of carbon flying through the air inside of the combustion chamber, and these particles are not completely burned when the gases reach the tubes, and will then deposit themselves on the tubes. Also, these heavy particles in the pulverized-coal mixture will sometimes settle on the bottom of the combustion chamber and will soon build up in the shape of stalactites. This accumulation will continue to build until the bottom of the combustion chamber continues to be raised, until it comes in contact with the flame. These built-up particles will then fuse into a solid mass, which in a very short time will cause a shutdown of the boiler to dig this fused mass out.

STUDY OF BOILER-HOUSE INSTALLATIONS

Before installing, or considering the use of pulverized coal under boilers, we must first make a study of our boiler-house installation and know at exactly what rating we wish to operate these boilers, considering any peak load which may develop. We must then design the combustion chamber large enough to take care of the maximum loads which will be developed. After this maximum rating has been determined, we then figure the combustion chamber of a cubical capacity equivalent to approximately 50 cu.ft. per lb. of coal burned per min., or approximately 2½ cu.ft. per hp. developed by the boiler.

If we decide to run this boiler at 150 per cent. of this rating and design the combustion chamber accordingly, the efficiency will not be decreased perceptibly if the boiler is run under this 150 per cent. rating, but if we develop over a 150 per cent. of the rating, we meet difficulties. We have to admit more coal and air to the boiler to develop the greater rating, consequently we need more combustion space, but not having this combustion space, the flames impinge on the brick and cut it away very rapidly. Also, combustion is not complete at the time the gases strike the bottom row of tubes and consequently the gases will pass up the stack unburned. If the gases are not completely burned by the time they reach the first row of tubes, they will not burn later on in the boiler. The size of the combustion chamber should also be so designed that the velocity of the gases should not pass through this combustion chamber at a speed of more than 6 ft. per sec. The mixture of air and coal entering the combustion chamber, as previously stated, should be at as low a pressure as is possible to bring this mixture in suspension.

PRESSURE AT WHICH COAL IS ADMITTED

The pressure at which the pulverized coal is admitted to the furnace is about half an ounce at the nozzle. In some installations the coal falls by gravity from the variable-speed screw conveyor, located on the bottom of the pulverized-coal bin, into a fan air line which carries it into the furnace and also supplies the necessary air for combustion. Some few openings are placed in the front wall of the boiler to give any additional air which may be needed, and a few may also be placed on the side walls of the boiler to protect the brickwork at times.

In other installations the amount of air necessary to convey the coal into the furnace varies, according to the rate at which the boiler is being operated. The balance of the air to burn the coal properly is admitted through adjustable air openings in the front, sides and bottom of the combustion chamber. These openings are made adjustable and are placed on all sides of the combustion chamber to take care of the various grades of coal which may be used. By properly observing the combustion in this chamber, by a little experience the fireman knows at exactly what points to give more or less air needed for combustion.

ACCURATE DAMPER REGULATION NECESSARY

To give the proper velocities of gases passing through the combustion chamber, it is necessary that we have accurate damper regulation to take care of the various load conditions. The damper should be so regulated that there is practically a balanced draft inside of the combustion chamber and only a slight vacuum in the first pass, while at the damper itself there should be not more than 0.10 to 0.15 in. With more vacuum than this, it pulls the gases through the combustion chamber too fast, causing them to be unburned before reaching the first row of tubes. This small draft needed at the base of the stack will allow us to operate boilers using pulverized coal with stacks of about 30 to 35 ft. in height.

The keeping clean of the outside of the tubes is necessary with the use of pulverized coal, and they should be blown by means of mechanical soot blowers at least every six hours, and oftener if it is necessary. Also, once every 24 hours by means of a hand-lance steam jet we should blow the bottom of the first row of tubes.

Ash that deposits at the bottom of the combustion chamber should be removed at regular intervals, which intervals will be determined by the amount of ash in the original coal. If not removed regularly, it will build up until it comes in contact with the flame, when it becomes fused and has to be dug out. But if removed at regular intervals, it can be easily raked out with the ordinary boiler-room ash rake and will not consume more than half an hour per 24 hours, and will not interfere with the operation of the boiler while this is being done.

ADVANTAGES OF PULVERIZED COAL

The following are some advantages of pulverized coal as a fuel for boilers over stokers:

1. Much wider variation in the quality of the coal usable is obtained when burning coal in pulverized form. Practically any and all grades of coal can be burned in this form with economy. No stoker will satisfactorily handle all grades of coal.

2. Ability to take care of peak loads almost instantaneously. Its flexibility approaches that of oil or natural gas.

3. The amount of coal that can be burned per square foot of grate surface on stokers is limited so that for increased capacity the boiler setting must be spread out to cover more area. When using pulverized coal, this condition does not exist, for proper furnace conditions can be obtained by increasing the height of the boiler setting or the depth of the combustion chamber.

4. By throwing a switch the entire firing operation ceases, an advantage in case of accident or emergency.

5. Ash is in much better condition to handle. The ash is in the form of a dust or slag, depending upon its melting point.

6. Since there are no grates used when the fuel is burned in pulverized form, we experience no clinkering.

7. Pulverized coal is fired dry, containing less than 1 per cent. of free moisture, whereas coal burned on stokers may vary anywhere from 1 to 10 per cent. of free moisture as fired.

8. Considerable less excess air is necessary for complete combustion. This item is of the utmost importance when making comparisons. Less draft is required for pulverized-coal-fired furnaces.

9. All the combustible in the coal is consumed when it is burned in pulverized form, provided the furnace capacity is not exceeded. None of the combustible goes out into the ash pile and therefore fires are eliminated in the ash pile.

10. There is less erosion from sulphur on the boilers due to less moisture in the coal as fired, therefore high-sulphur coals can be burned more readily and without serious result.

11. With furnace properly proportioned and with properly designed burning equipment smokeless operation may be maintained indefinitely.

SOME POINTS TO BE KEPT IN MIND

The following few points must be kept in mind for the successful burning of pulverized coal under boilers:

A boiler furnace using pulverized coal should have as few burners as is possible consistent with good regulation. The burners must be proportioned for the maximum rating of the boilers, and they must be adjustable. Simplicity of design is desirable. It has been found more desirable to introduce coal into the furnace as far away from the side walls as possible so that the rapid continuous expansion of the gases will not develop high velocities in close contact with the furnace refractories. Furnaces under boilers should be proportioned so that the velocity of the gases should not be excessive, particularly at the smallest cross-sectional area of the furnace. Vertical baffles should replace all horizontal baffles.

A boiler of any size can be fired successfully with pulverized coal. Various designs and makes of boilers can be readily arranged for pulverized-coal firing, but those containing the smaller percentage of space for the lodgment of ash are preferable.

Feeders for regulating the flow of pulverized coal to the furnace must be designed so that at all times the variation in quantity will be directly proportional to the speed of the screw and no flooding allowed. The speed of the feeder should be so regulated that operating at its maximum r.p.m. the supply of pulverized coal to the furnace will not exceed the capacity of the furnace. Soot blowers should be installed in settings where pulverized coal is used.

TABLE IV. TEST OF A PULVERIZED-FUEL-BURNING STATIONARY BOILER

Make of boiler				Edge Moor
Rated hp.				468
Heating surface, sq.ft.				4685
Duration of test				24 hours
	Maximum	Minimum		Average
Temperature of boiler room, deg. F.	99 0	85.0		93 3
Temperature of feed water, deg. F.	168.0	135.0		157.2
Temperature of steam, deg. F.	477.0	427.0		448.7
Barometer, in. of mercury	29.35	29.20		29.25
Temperature of flue gases, deg. F.	515.0	455.0		495.3
Average boiler pressure, lb.				167.0
Temperature of steam, deg. F.				373.8
Superheat, deg. F.				74.9
Factor of evaporation				1 1502
Water evaporated from and at 212 deg. F. per lb. of coal, lb.				9.47
	Maximum	Minimum		Average
Carbon dioxide (CO_2), per cent.	15.4	12.2		13.85
Oxygen (O), per cent.	5.6	3.2		4.38
Carbon monoxide (CO)				None
Fuel used				Bituminous screenings
Fuel Analysis	No. 1	No. 2	No. 3	Average
Amount of coal represented by each sample, lb.	19,775.0	20,000.0	8,000 0	....
Per cent. of total.	41.3	41.1	16.9	....
Moisture, per cent.	10.3	11.0	9.7	10.49
Volatile, per cent.	33.81	36.96	38 77	35.96
Fixed carbon, per cent.	50.43	49.13	48.29	49.53
Ash, per cent.	14.36	13.91	12.94	13.93
Sulphur, per cent.	1.90	2.06	2.12	2.04
B.t.u., as received	10,600.0	10,763.0	11,263.0	10,779
B.t.u. dry	11,817.0	12,093.0	12,473.0	12,045
Flues blown during test				5 times
Horsepower				546.2
Per cent. of rating				116.7
Boiler efficiency, per cent.				85.22
Memoranda—Fuel-preparation deduction:*				
Coal used in drier, lb.				1,140
Motor operation, kw.-hr.				449.3
Coal equivalent at 3 lb. per kw.-hr., lb.				1,348
Total deduction, lb				2,488
Resulting net efficiency, per cent.				81.1

*No deduction made for stand-by losses in drier.

The equipment for using pulverized coal is standard for any grade of coal so far as handling, preparing and delivering to the furnace is concerned. Only a slight change is necessary in the furnace to take care of coals of very low volatile content, such as anthracite, culm and coke breeze, and increased drying capacity is desirable when lignite coal is used. With stokers this is not the case as the varying quality of coals require different type stokers to obtain highest efficiency.

SAVING IN LABOR COST

The labor required to operate a pulverized-coal installation may be of higher class, but the number of men required will be less in the larger installations than that required for a stoker installation, thereby affecting a saving in the labor charge in favor of pulverized coal.

Table IV is a report of a test made on a 468-hp.

boiler using pulverized coal as fuel. The boiler is a three-pass water-tube boiler, with superheater.

At this same plant are other boilers fired by one of the most efficient types of underfeed stokers. A comparison is made between results of foregoing test and tests made on the stoker-fired boilers.

PULVERIZED COAL VS. MECHANICAL STOKERS

Under this heading fuel-preparation costs will first be considered. In the case of powdered coal this can be classed under three general divisions:

The cost of crushing the coal. This expense is the same for pulverized-coal equipment as for stokers.

The cost of drying and pulverizing the coal. Although no cost records are available at present, it is estimated that 32c. per ton will cover this preparation cost on a 200-ton-per-24-hr. plant using bituminous coal containing about 12 per cent. moisture.

The maintenance costs of the drying and pulverizing plant. This unit has not been determined from actual experience; however, it is estimated that 3c. per ton will cover the maintenance. In stoker practice the maintenance cost per ton of fuel fired is close to 5c. per ton.

Summarizing the foregoing facts, it is evident that with fuel at $5 per ton the gross efficiency shown by the pulverized-fuel boilers will have to exceed that shown by the mechanical-stoker-fired boilers by 6 per cent. to offset coal-preparation costs.

Discussion by Albert A. Cary

In the early part of 1831 an English patent was issued to J. S. Daws for a process for burning powdered coal, and this was rapidly followed by a large number of patents relating to this subject in England, in the United States, in Germany and elsewhere, and descriptions of the varied use and application of such equipments will be found scattered through many of the old engineering publications.

In April, 1881, nearly 40 years ago, a United States patent was issued to C. H. Palmer, describing the means for feeding fine coal to a locomotive boiler with an air blast. In 1870, Whelpley & Storer began to take out a series of patents for using pulverized coal in reverberatory metallurgical furnaces. In 1876, an elaborate series of tests were conducted by the United States Steam Engineering Bureau of the Navy Department under the direction of B. W. Isherwood, using the Whelpley & Storer pulverized-coal system applied to a steam boiler.

During the last decade (or even for a much shorter period) there have been many powdered-coal installations made for various applications, which have been followed by rejections, or in other cases they will be found giving poor satisfaction and failing to realize the enthusiastic claims that led to their installation.

In the light of my experience and with the evidence presented by many satisfactory equipments now in operation, I am an unqualified advocate of the use of such fuel. But I certainly limit my indorsement to applications where a desirable grade of fuel is available, where proper preparation of the fuel and proper furnace conditions can be obtained and where other methods for burning the available fuel are inferior to accomplish the desired heating.

Recent developments have done much to overcome difficulties formerly experienced with the use of pulverized coal in stationary boiler plants, and consequently we find, today, a number of such installations in use, some of them showing desirable economy and producing a material increase in the steaming capacity of the boilers. A few such installations have been made in central power stations where the result of their experience is being watched with much interest.

With the close proximity of the heating surfaces of the boiler, care must be taken to prevent the unconsumed coal from coming in contact with such chilling surfaces. This requirement demands the use of a properly constructed extension furnace in which the complete combustion of the coal should be accomplished and in which proper handling of the fine ash (and its resulting slag) should be cared for.

All that applies to extension furnaces applied to short reverberatory furnaces applies with equal force to steam-boiler furnaces.

The cost of a milling plant for properly drying and pulverizing the coal, as well as the space required for its installation, often proves an obstacle to the installation of such equipment.

With the intense heat generated in burning pulverized coal, much trouble has been experienced in improperly designed boiler furnaces owing to the rapid melting down of the refractory linings, which linings may also be subjected to the scouring or cutting action of impinging ash.

The type of furnace used has much to do with the quality of coal required to obtain the best results, but generally speaking, such coal as Mr. Harrison describes, averaging between 30 and 40 per cent. in volatile and between 40 and 50 per cent. in fixed carbon and low in percentage of ash, will give excellent results.

Generally speaking, the presence of a considerable percentage of volatile combustible matter is most important as may be appreciated when we consider the progress of combustion taking place with this class of fuel.

Pulverized coal *must* be burned while suspended in the current of air which accompanies it into the furnace.

As the finely divided coal enters the highly heated furnace, any moisture each minute particle contains is first driven out, and if this is excessive, it will form a steam cloud around the particle and suppress its further rapid combustion, thus defeating to a greater or less extent, the purpose for which the coal was prepared. One of the necessities for supplying the furnace with very dry pulverized coal is thus appreciated.

With little or no moisture present, the next effect of the very high surrounding temperature in the furnace is to almost instantly distill off the volatile matter occluded in the coal as this gas is liberated at a comparatively low temperature and thus, with properly designed furnace and burner, the dust cloud entering the combustion chamber suddenly becomes thoroughly saturated with a highly inflammable gas, mixed with an ample supply of air. Under these conditions the gas is raised with great rapidity to its ignition temperature and the flame produced is propagated with intense speed throughout the atmosphere of fuel and air entering the furnace; all of which is simultaneously subjected to the same action.

With the intense degree of heat thus generated, not only is the temperature of the furnace maintained to stimulate further combustion, but the particles of fixed carbon (or flecks of coke) left behind, after the volatile gases have been driven out of the coal, have their temperature raised with great rapidity to their temperature of ignition, and so are most speedily burned, leaving behind the noncombustible matter to be more or less effectively taken care of in a properly designed furnace, or to give great trouble in furnaces where its importance has been ignored.

The effect of the decreased surface in proportion to the mass results in a very great retardation of the combustion of the larger particles, as is very plainly shown in the photographic study of the combustion of coal dust in Bulletin No. 102 of the Bureau of Mines, entitled, "The Inflammability of Illinois Coal Dusts," on Plate IV.B and Plate V.B.

Uniformity in the size of pulverized particles is also very desirable. When coal averaging from 30 to 40 per cent. of volatile matter is pulverized so that over 90 per cent. will pass through a 200-mesh screen, the finer coal accompanying it does not seem to materially affect its even rapid burning effect in general furnace practice, and further, as Mr. Harrison has stated on Page 13 of his paper, with this very fine pulverization, which insures rapid and high temperature combustion, the sulphur in the coal burns rapidly to SO_2 gas, which passes to the stack without affecting the product of the reverberatory furnace.

When a coal running high in fixed carbon is used as pulverized fuel, we have a different and less desirable set of furnace conditions.

Lacking the production of an ample supply of volatile combustible gases, also lacking the heating effect which the burning of these gases produce, to hasten the combustion of the associated fixed carbon, we must necessarily maintain a higher furnace temperature to ignite this fuel, and to obtain the best possible result the coal should be ground finer.

There is a considerable range in cost of equipments as furnished by different concerns, and the figures presented in this table appear low for the better class of equipment. Again, should you decide to grind the coal very fine to obtain maximum furnace results, the output capacity of the pulverizer would be materially reduced below that needed for coarser pulverization and more or larger mills would be needed.

Whereas, Mr. Harrison's total cost for pulverizing 80 and 90 tons of coal per day agrees pretty well with the cost estimate given in this table, his cost for producing 100 tons per day runs 21 per cent. higher than the figure shown in the table.

In looking over the log of the boiler test given in Mr. Harrison's paper, I notice what appear to be a few discrepancies, but lacking full and complete data, I have been unable to check them.

Taking his analysis of furnace gases, he gives the maximum result obtained as 15.4 per cent. of CO_2 and 5.6 per cent. of O with no CO. This is consistent and possible.

He then gives his minimum result obtained as 12.2 per cent. of CO_2 and 3.2 per cent. of O with no CO; the sum of these gases giving 15.4 per cent. with 84.6 per cent. of N by difference.

There is evidently some discrepancy here, as I do not see how it is possible to burn such a coal as he indicates so as to obtain such an analysis.

The figures also given by him in his average gas analysis are not consistent. The percentage of boiler efficiency given in this table, as 85.22 per cent. seems on the whole entirely inconsistent, and I cannot find sufficient indication, contained in the other data submitted, to assure me that the total losses in the performance of this test amounted to only 14.78 per cent.

Pulverized Coal for Stationary Boilers*

By FREDERICK A. SCHEFFLER and H. G. BARNHURST

It is the purpose of this paper to present those facts which the authors believe indicate the coming general adoption of pulverized coal as a fuel for boilers. Since stoker firing is the most efficient method when solid fuels are used, a comparison of stoker and pulverized-fuel plants is given, with particular reference to reliability, cost, adaptability and efficiency.

THE ULTIMATE adoption of a new method depends entirely on its over-all commercial efficiency. In the generation of power, over-all efficiency may be considered as composed of the following factors: reliability, cost and adaptability.

Let us compare the reliability of a pulverized-coal installation with that of stokers. This factor depends on two items—apparatus for preparing and presenting the fuel for combustion, and continuity of operation of the furnace itself. In a stoker installation the first of these includes the stoker itself. Neglecting the inherent defects of any system that presents a metal mechanism to the action of high temperatures, it may be admitted readily that the stoker sysem is satisfactorily reliable, with respect to its apparatus, for preparing and presenting the coal for combustion.

The corresponding mechanisms for pulverized fuel are equally reliable. This fact is proved by their widespread use for years in the cement industry and more recently in an ever-increasing variety of industries. These mechanisims are not innovations, but are the result of years of development under operating conditions. Proper design of equipment by engineers of standing who are specialists in this line has made negligible the danger of dust explosions.

Cost per B.T.U. Delivered to Boiler

The second condition for reliability is the continuity of operation of the furnace. Here again we find an apparent balance between stoker and pulverized-fuel installations during operation. The advantage lies with pulverized fuel, however, for several reasons. The mechanism is altogether outside the furnace, hence cleaning and adjustment and the making of the few repairs required need not interrupt the operation of the boiler. In case of sudden necessity the fire may be ignited and quickly brought to full intensity, or it may be extinguished almost instantly.

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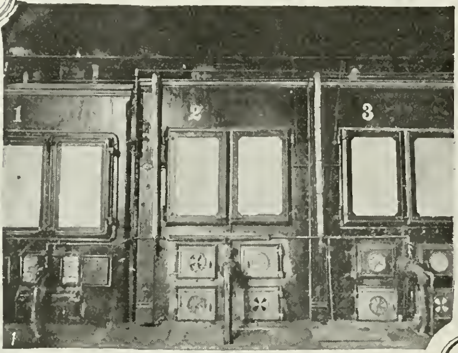
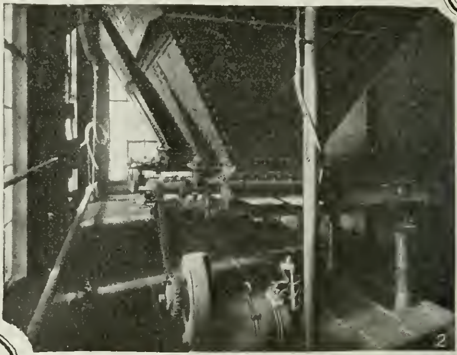
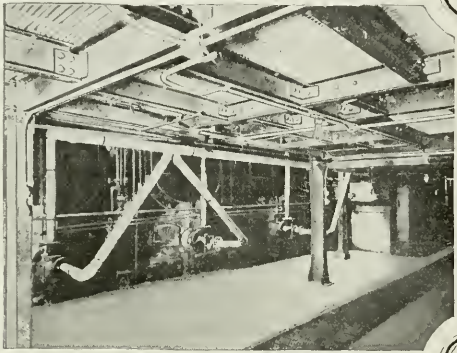
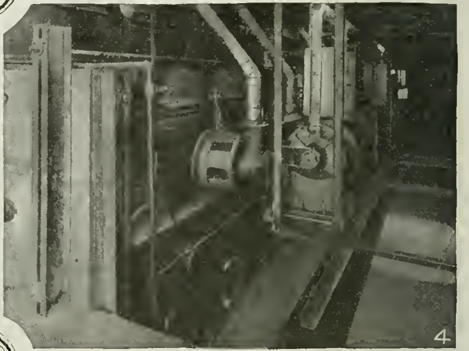
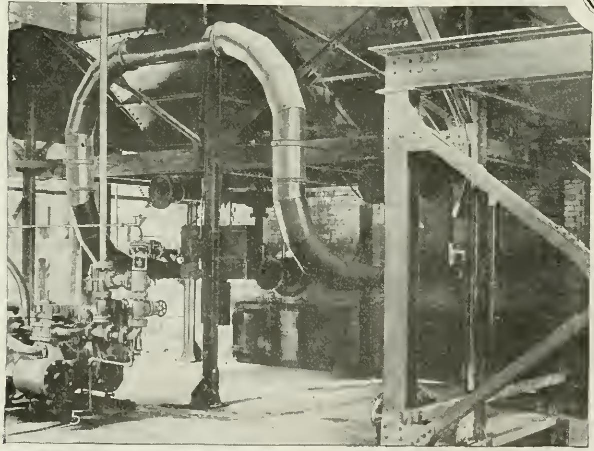
*An abstract of a paper presented at the Spring Meeting of the American Society of Mechanical Engineers, Detroit, Mich., June, 1919.











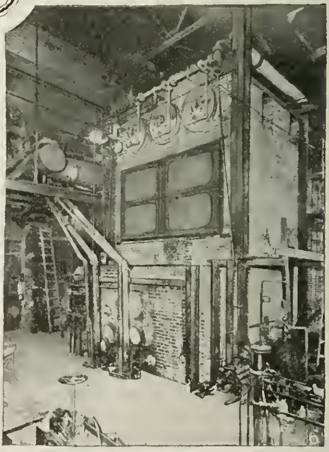


Fig. 1—Boilers at Broadway High School, Seattle, Wash. Fig. 2—Feeder for two 50-hp. Badenhausen Boilers, British Columbia Sugar Refinery Co., Vancouver, B. C. Fig. 3—Three 150-hp. Return-tubular Boilers, British Columbia Sugar Refinery Co., Vancouver, B. C. Fig. 4—Burners for two 50-hp. Badenhausen Boilers, British Columbia Sugar Refinery Co., Vancouver, B. C. Fig. 5—Two 430-hp. Stirling Boilers, United Verde Extension Mining Co., Jerome, Ariz. Fig. 6—One 600-hp. Boiler, Western Avenue Station, Puget Sound Traction, Light and Power Company, Seattle, Wash.

The second factor, cost, refers to the cost per B.t.u. delivered to the boiler. The various items entering into this cost by the stoker system comprise power, repairs and maintenance, labor, interest on investment, depreciation, insurance and taxes. With pulverized-coal equipment the cost of fuel for the drier should be added to the preceding items. A moment's consideration will show that this item must be taken care of in the furnace of a stoker-fired boiler and that it is clearly cheaper to remove the excess moisture content from the coal in a drier, from which the gases leave at very low temperature, than in the furnace itself, where the evaporation of the moisture damps the fire, increases the content of inert gases and at the same time carries off an appreciable amount of heat.

Returning to the balanced cost items, it appears that these show a saving in favor of pulverized fuel in a large power plant and for the stoker in a small power plant. It should be noted that when central pulverizing plants are built, they will relieve small power plants of the necessity for maintaining pulverizing equipment and make pulverized fuel considerably cheaper than stoker-fed fuel, regardless of the size of installation.

The flexibility in the use of pulverized fuel is perfect, and the fire may be instantly adjusted to suit any condition of overload or lower load, including the cutting in and out of the boilers. The paramount importance of this feature and the utter impossibility of approaching it with stoker or grate firing is readily evident.

THE DESIGN OF FURNACES FOR PULVERIZED COAL

The primary requisite for good results is to maintain low velocities in the furnace. The combustion is no less perfect with high velocities, but this will result in damage to the linings and in their erosion. A furnace cubical in shape usually gives the most satisfactory results.

The burners should inject the coal under low pressure and should permit of varying the density of the mixture in the burner itself. Their location and number will depend on the size of the boiler and rating required, and also may be varied to suit the grade of fuel. High boiler ratings such as are used in modern boiler practice can be obtained when desired, and such overratings should be predetermined and the furnace volume designed accordingly.

In Table I will be found an itemized statement of the costs of pulverizing coal. Table II gives a list of boiler installations using pulverized coal and Table III reports of preliminary tests made on some of the pulverized-fuel installations now in operation.

COST OF PULVERIZING COAL

The cost of pulverizing the coal is of prime importance as low costs are essential for success and are achieved when the quantity used per day of 24 hours exceeds 100 tons. The cost of pulverizing is made up of a number of items as follows:

Power, repairs and maintenance, coal for drying, labor, interest, depreciation, insurance and taxes.

The power required in an up-to-date pulverized-coal plant is from 12 to 13 kw.-hr. per net ton of coal crushed, dried and pulverized. The additional power required for transferring the coal to the point of use and feeding it to the boilers will vary considerably, depending upon the distance transported, the size and number of the boilers and the conditions under which they operate. The power required for this latter purpose varies between 4 and 6 kw.-hr. per net ton, so that the total power for the entire process from the track and storage delivered to the boilers is 17 or 18 kw.-hr. per net ton. In the following paragraphs the cost of power has been assumed at ¾c. per kilowatt-hour.

The items of repairs, including material, labor and general upkeep of the plant or maintenance for the entire pulverizing plant and burning equipment will vary from 7 to 10c. per net ton of coal handled. The figures depend upon local conditions, and the size and general arrangement of the installation.

The item of coal for drying depends directly upon the percentage of moisture and upon the price of coal. Ordinarily, only from 1 to 1¼ per cent. of the total amount of coal used is required for drying. Assuming coal to have an average of 7 per cent. moisture as received and the cost to be $2.50 per net ton, the cost per net ton of drying the coal will be 3c. At $5 per net ton the cost of the drier coal will be 6 cents.

The labor item is the greatest variable in connection with the pulverizing of coal, owing to the increased output that can be obtained in larger plants per man employed. It is also subject to local rates of wages. For example, assuming labor at 40c. per hour, a plant of 100 tons daily capacity, properly designed and equipped, will require approximately 34 labor hours to prepare the fuel and deliver it to the conveyors, whereas in a plant having a daily capacity of 1000 tons, approximately 115 labor hours are required. Therefore the labor cost would be 14c. per net ton in a 100-ton plant, only 4c. per net ton in a 1000-ton plant, and as low as 2½c. per net ton in a plant of 5000 tons daily capacity.

TABLE I. COST OF DELIVERING PULVERIZED FUEL TO BOILERS

	100-Ton Plant, Dollars per Net Ton	1000-Ton Plant, Dollars per Net Ton
Power at ¾c. per kw.-hr. and 17 kw.-hr. per net ton	$0.1275	$0.1275
Labor at 40c. per hour	.14	.04
Drier coal at $5 per net ton delivered	.06	.06
Repairs	.07	.07
Total actual cost of pulverizing per net ton	$0.3975	$0.2975
Interest at 6 per cent	$0.105	$0.039
Depreciation	.12	.04
Taxes and insurance	.035	.013
Total cost per net ton	$0.6575	$0.3895

The interest item is based on 6 per cent. of the entire investment, and the cost of the pulverized-coal plant and burning equipment will of course vary considerably with the conditions under which the plant itself is installed. Roughly speaking, however, the actual investment will vary from $12.80 per kw. output in a 5000-kw. plant down to $4.80 per kw. in a 50,000-kw. plant and $4.12 in a 100,000-kw. plant (assuming a turbo-generator water rate of 16 lb. and continuous boiler and furnace efficiency of 75 per cent.).

All these figures in relation to cost are based on the present high prices. The investment required for a 5000-kw. plant using 100 tons of pulverized coal daily is approximately $64,000 and for a 50,000-kw. plant using 1000 tons of pulverized coal daily, approximately $240,000, so that, on a basis of 6 per cent. and allowing for 365 days' continuous operation, the interest item will vary from 10½c. per net ton in a 100-ton plant down to 3.9c. per ton in a 1000-ton plant.

Depreciation in a coal-pulverizing plant is usually calculated as follows The life of the building is considered as 40 years, of the coal driers as 15 years and of the balance of the equipment as 20 years. With a 100-ton pulverized-coal plant and burning equipment the depreciation item will be approximately 12c. per net ton.

and in a plant of 1000 tons daily capacity it will be approximately 4c. per net ton.

Taxes and insurance are based on 2 per cent. of the entire investment and for a 100-ton plant this item is approximately $3\frac{1}{2}$c. per ton and for a 1000-ton plant, $1\frac{3}{10}$c. per ton. Summarizing the foregoing results shows that the total cost of pulverizing and delivering pulverized coal to boilers is approximately as in Table I. The cost of the pulverizing equipment complete compares favorably with the stoker equipment when everything, such as coal- and ash-conveying machines, etc., is taken into consideration, and in large plants it is considerably less.

TABLE II. BOILER INSTALLATIONS USING PULVERIZED COAL

Date of Installation	Name of Company	Location	No. of Boilers	Horsepower Rating and Make of Boilers	Furnace Design, Per Cent. of Rating	Coal Used
Aug., 1916	M. K. & T. R.R.	Parsons, Kan.	8	250 O'Brien	125–150	McAllister Cherokee slack, Kan., semi-anthracite, Texas lignites San Bois coal, Oklahoma
Nov., 1916	American Locomotive Co.	Schenectady, N. Y.	1	300 Franklin	150	
June, 1918	U. S. Verde Extension Mining Co.	Verde, Ariz.	2	439 Stirling	150	Gallup and semi-lignite
Feb., 1918	Ash Grove Lime and Cement Co.	Chanute, Kan.	1	371 Heine	150	Various grades of Kansas coals
June, 1918	Garfield Smelting Co.	Garfield, Utah	2	371 Stirling	150	Wyoming lignite, Wyopa, Wyoming lignite. Keystone, Utah, bituminous from various mines
Nov., 1918	Puget Sound Light and Power Co.	Seattle, Wash.	10	4–300 B. & W. 2–600 B. & W. 3–400 B. & W. 1–500 B. & W.	150	Renton buckwheat, Washington bituminous lignite and sub-bituminous
Nov. 1917	Sizer Forge Co.*	Buffalo, N. Y.	5	250 Rust	125	Pittsburgh and Pennsylvania
Mar., 1919	British Columbia Sugar Refinery Co.	Vancouver, B. C.	13	2–504 Badenhausen 2–250 B. & W. 9–110 HRT	150	Vancouver, B. C., bituminous and lignite
July, 1918	Milwaukee Electric Railway & Lighting Co.	Milwaukee, Wis.	5	468 Edge Moor	150	Indiana and Illinois bituminous, Pittsburgh and Youghiogheny
Mar., 1919	Allegheny Steel Co.	Allegheny, Penn.	1	333 Wickes	...	Pittsburgh coals
June, 1919	Inland Steel Co.	Chicago Heights, Ill.	1	250 Heine	150	Illinois bituminous
June, 1918	Pacific Coast Coal Co.	Seattle, Wash.	10 8	150 HRT 100 HRT	... ...	Renton buckwheat Washington bituminous, lignite and sub-bituminous
Nov., 1918	Susquehanna Collieries Co.	Lykens, Penn.	1	250 B. & W.	200	All grades of anthracite washery culm, mine dirt, No. 3 buckwheat, Lykens slush, Lytle slush
June, 1919	Lytle Coal Co.	Lytle, Penn.	6	333 B. & W.	200	All grades of anthracite, washery culm, Lytle slush
May, 1919	Garfield Smelting Co. (2d installation)	Garfield, Utah	4	371 Stirling	150	Wyoming lignite, Wyopa, Wyoming lignite, Keystone, Utah, bituminous from various mines
Sept., 1918	L. S Smith Bldg.	Seattle, Wash.	2	1–300 B. & W. 1–200 B. & W.	... ...	Obtain and use coal from Pacific Coast Coal Co.
Sept., 1918	Crystal Natatorium	Seattle, Wash.	2	72 x 18 HRT	...	Obtain and use coal from Pacific Coast Coal Co.
Sept., 1918	Crystal Natatorium	Seattle, Wash.	2	72 x 18 HRT	...	Obtain and use coal from Pacific Coast Coal Co.
Sept., 1918	Pacific Coast Coal Co.	Seattle, Wash.	12	2–250 Wickes 2–125 Ames (72 x 16) 6–125 Chandler & Taylor 2–125 Casey-Hedges	..	Obtain and use coal from Pacific Coast Coal Co.

*Also use some waste heat from pulverized-coal-fired furnaces.

TABLE III. REPORT OF PRELIMINARY TESTS MADE ON PULVERIZED-FUEL PLANTS

Date of Test	Location of Plant	Duration, Hours	Coal Used	Efficiency Maintained, Per Cent.	B.t.u. per Lb. of Coal as Fired	Ash, Per Cent.	Rating Per Cent.
Apr. 16, 1917	Seattle, Wash.	14.5	Renton buckwheat	77.0	10,000	11.60	122.0
Dec. 4, 1917	Chanute, Kan.	5.0	Kansas bituminous	72.0	11,996	17.7	125.0
Dec. 12, 1917	Chanute, Kan.	5.0	Kansas bituminous	83.94	12,500	18.25	125.0
Jan. 28, 1918	Chanute, Kan	(25 days)	Kansas bituminous	78.1	11,435	...	100.0
Apr. 26, 1918	Parsons, Kan	6.0	Kansas bituminous	80.3	12,900	17.49	.....
Apr. 28, 1918	Parsons, Kan	6.0	Kansas bituminous	80.9	12,289	17.49	130.8
June 14, 1918	Milwaukee, Wis.	12.0	Illinois and Indiana screenings	83.3	10,897	15.89	117.7
Nov. 5, 1918	Lykens, Penn	10.0	Lykens No. 3 buckwheat anthracite	84.2	12,530	16.92	135.0
Nov. 15, 1918	Lykens, Penn	5.0	Lykens slush buckwheat anthracite	81.2	13,653	11.09	142.0
Nov. 22, 1918	Lykens, Penn	5.0	Lykens slush buckwheat anthracite	85.0	12,753	18.04	146.0
Nov. 23, 1918	Lykens, Penn	5.0	No. 3 buckbweat anthracite	72.7	12,530	16.91	115.0
Dec. 2, 1918	Lykens, Penn	5.0	Lytle slush anthracite	75.3	15,420	23.92	188.0
Feb. 1, 1919	Seattle, Wash.	24.0	Issaquah screenings	78.95	11,660	14.31	126.0
Feb. 2, 1919	Lykens, Penn	4.0	No. 3 buckwheat anthracite	78.9	13,067	14.02	177.0
Apr. 7, 1919	Vancouver, B. C.	4.0	Nanaimo slack	83.3	9,364	28.4	125.0
Apr. 17, 1919	Vancouver, B. C.	5.0	Nanaimo slack	77.1	10,050	24.3	160.0
Feb. 3, 1919	Lykens, Penn	5.5	No. 3 buckwheat anthracite	78.9	12,530	14.00	.....
Sept. 24, 1918	Verde, Ariz	(6 days)	Gallup, New Mexico.	79.5	10,680	14.31	155.0

Discussion by Thomas A. Marsh

The general proposition of taking raw coal with all its byproducts and preparing it to the most expensive size (pulverized) and then burning still raw coal and losing the byproducts appears to be a move much in the wrong direction. Pulverized coal has a field, no doubt; for instance, such lignites as cannot be burned on stokers. This field is limited, however, for chain grates are now developed to burn lignites containing 30 to 35 per cent. moisture, which embraces practically all but those of the North Dakota field.

It is evident from this paper that even to make a comparison for steam boilers it is necessary to represent pulverized fuel at its best, to hint at not a drawback or trouble, to submit tests of four or five hours' duration, and evidently not made under the A. S. M. E. code, to favor this equipment in figures in every way and to contrast stokers of the most expensive type to operate as to power to drive and as to power for fans. If it is necessary to resort to such extremities to make a comparable showing for pulverized fuel, it cannot be said that it is on a competitive basis with modern automatic stokers and furnaces.

Speaking of reliability, the authors state unqualifiedly that the mechanisms for pulverizing fuel are equally reliable with those for crushing coal for stokers. The extra equipment necessary for this exceedingly elaborate preparation of the fuel is another link, and a high speed one at that, to the mechanism. No engineer will agree that the combination of a crusher system and a pulverizing system is equally reliable to a crusher alone.

The writer understands that cement plants are usually equipped with duplicate pulverizing systems.

It is mentioned that all grades of coal can be used. There are stokers which have limitations only on anthracite or coke braize, and in this connection the question arises as to whether a pulverized-coal furnace and burner designed for, say, bituminous 35 per cent. volatile will burn anthracite or coke braize. I ask this because in one other technical society it is a matter of recent record that for burning low-grade anthracite or coke braize in pulverized form, reversal of the flame is necessary, a firing method not suitable for the richer bituminous coals. It was also brought out that with coke braize or anthracite culm, the fire was unresponsive and the load had to vary to suit the fire rather than the fire to suit the boiler load. What occurs when a rich, high-grade fuel is used in a furnace and burner designed for low-grade fuels? It is mentioned that the primary feature is the possibility of burning all grades of fuel without affecting the efficiency of the furnace. For this to be true, it is necessary to burn the 50 per cent. ash coal with no more excess air than the 3 per cent. ash coal and suffer no more ashpit loss in the former case than in the latter. The writer therefore specifically asks if the 50 per cent. ash coal requires in practice no more air than the 3 per cent. ash coal. When 50 per cent. ash coal is used, the sensible heat of this amount of refuse leaving the furnace chamber is in itself an item that will affect the efficiency of the furnace. Now, therefore, can efficiencies be independent of these items? The tests show wide variation in efficiencies. What causes these wide variations?

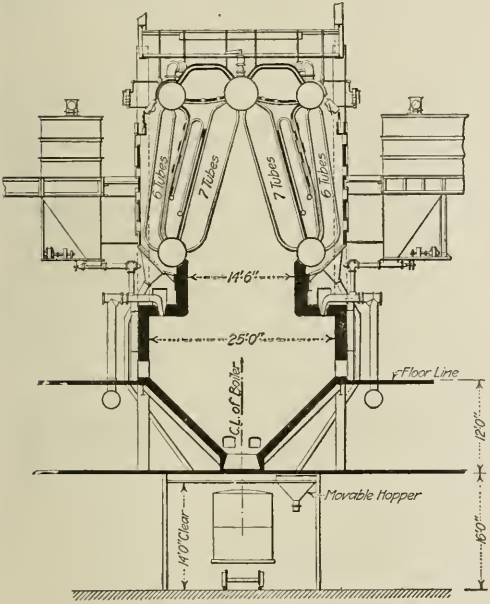


FIG. 1. DETROIT EDISON TYPE 2400-HP. BOILER ARRANGED TO BURN PULVERIZED COAL AT 200 PER CENT. RATING

Chain grates are, and have been for years, burning coals containing 35 per cent. ash and producing some excellent results. It is to be regretted that the authors in making this statement regarding high-ash fuels did not submit figures of tests with anything over 28.4 per cent. ash, a comparatively low figure as compared with chain-grate practice with Western fuels.

As to flexibility with pulverized coal, the writer has seen plants where the furnace became unresponsive when forced. There is certainly no evidence in the paper to prove or even indicate that the pulverized-fuel burner is quickly responsive over a wide range of loads; in fact, the evidence is much to the contrary, for of all the tests referred to, the maximum overload indicated is 188 per cent., which is not considered a high overload in modern practice. The writer would inquire if in the test at Seattle the heating value of the coal was determined by a calorimeter, or was it assumed? The even figure of 10,000 simply suggests an assumption.

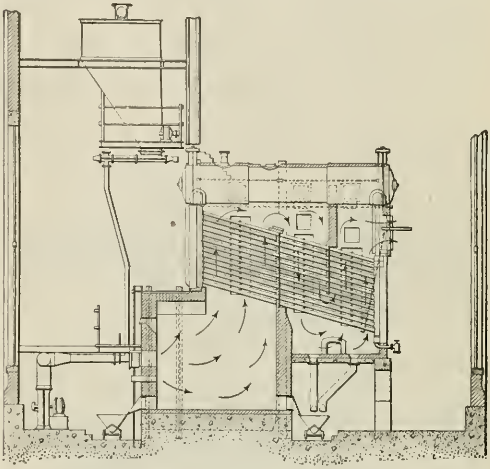


FIG. 2. BABCOCK & WILCOX BOILER ARRANGED TO BE FIRED WITH PULVERIZED COAL

What great difference brought about the marked increase in efficiency between the Dec. 4 and Dec. 12, 1917, tests at Chanute, Kan.? This wide difference is inconsistent with the statement of uniform efficiencies, regardless of operatives, coal or other items.

The authors have selected for comparison those types of stokers with which it is most difficult to get high operating efficiencies, whereas if the comparison were made with completely automatic stokers the statement made about the operating advantage becomes void.

All costs of pulverizing coal are based on only 7 per cent. moisture, and yet many of the fuels mentioned in the tests contain more than 7 per cent. Comparatively few fuels have as low as 7 per cent. moisture, particularly west of Pittsburgh. The figures run from 10 to 40 per cent. in the western section of the country, 15 per cent. predominating. The writer suggests that the drying coal cost be doubled.

As mentioned earlier, the pulverizing equipment should be duplicated to prevent shutdowns, which would of course raise the equipment's interest charge.

Now as to some of the items not mentioned in the author's paper.

Fine Ash: The writer understands that from 60 to 80 per cent. of the ash carries over to lodge in the tubes and combustion chambers, going out of the chimney to scatter over the surrounding country. This may by comparison not be objectionable in a cement mill or in some of the localities mentioned in the list of installations, but it is evident that if the Commonwealth Edison Co., for example, was to scatter fine ash from the 5000 or more tons of coal it burns daily, say 600 to 800 tons of ash (from one company) over Chicago, it would create a condition compared with which the worst smoke fog would seem like a paradise.

Slag in Tubes: Some installations have encountered trouble due to the fine ash slagging in the tubes. The writer would inquire how prevalent this is, how it is overcome or prevented and what influence high boiler ratings seem to exert on this.

Slag in Ashpits: The refuse from pulverized-fuel firing contains some combustible. It has been reported that the slag containing this combustible causes damage to ashpits. Is this a serious item of maintenance? It is reported that pulverized fuel if stored will pack and become difficult to handle. Where the container is jarred or vibrated, this action is reported to increase. How serious is this action? Does it interfere with the use of stored powdered coal? Does it preclude its use on shipboard?

Pulverized Coal, Coal Storage, and the Schultz System of Burning Fine Coal*

REGARDING pulverized coal the most important information in the committee's report was that one pulverized coal machinery company was now furnishing equipment for two 1200-hp. boilers in a central station. The results will be closely watched and reported upon. As for coal storage and burning of fine coal, the discussion brought out more things of interest than the report brought out.

Discussion

Chairman McClelland, Technical and Hydraulic Section—In Seattle a company is supplying powdered fuel to four or five installations in the city, apartment houses and office buildings, hotels, etc. They ship it in closed tank cars and deliver it in closed tank wagons, and it runs from the wagon by gravity into the customer's receptacles. But the difficulty comes in the grinding and powdering. The operation is not standardized. There are several types of materials and grinders; and it is here that one considering the use of such fuel should be careful. It is where the large part of the investment lies. If we can get some of these large coal companies to do the powdering and deliver the coal in that form, that will be a splendid thing for the isolated plants.

The charge for the coal in Seattle, pulverized and delivered at $7 a ton, is about $1.50 a ton for preparation.

Chairman Carle—The pulverized-fuel situation is a combination of pulverizing good coal and bad coal together. To extend its use to apartment houses, I understand a company has been organized in New York, which will deliver it in containers. The serious trouble is that nobody furnishes all of the apparatus and all of the engineering, although some are starting to. This situation is holding up the development. The builders must take up the whole situation—be responsible for the apparatus and all connected with it.

The user of powdered coal in a large Milwaukee power plant told me that since last May they have made observations on dust from pulverized-fuel furnaces and cannot find deposit of this dust on the Milwaukee roofs. They say it goes from six to ten miles away and then comes down in a moist form, as dew or rain comes down. The refuse or ash from pulverized fuel will stay in the air, as cigar smoke does, before settling.

I. E. Moultrop—I would like the chairman or Mr. W. L. Abbott to state something to the audience in relation to the Schultz method of burning coal.

W. L. Abbott, Chief Engineer, Commonwealth Edison Co., Chicago, Ill.—The device referred to has been installed under a boiler at the University of Purdue. It has some original principles; I saw it once some months ago and it was working fine. I organized a party of half a dozen later on to go and look at it, and found it working badly.

I have confidence in it. It is a device to burn ground coal rather than pulverized coal, and it consists of a circular furnace into which the ground coal is projected tangentially and burns while whirling in this circular box. Air is admitted through a hole in the center of the bottom, and the gases escape at the top through a hole in the center. Due to the whirling motion, the coal runs around on the interior circular surface, and burns while whirling. In that way the dust does not escape with the gases, which has to go through the center. In whirling around the coal is gasified and there is opportunity for it to burn in the secondary furnace above this retort where it is gasified. The ash from the retort is supposed to trickle down like molasses candy, and to solidify before it strikes the ashpit. It forms a pyramid of molten beads which cool off.

The largest permissible size of coal, according to the inventor, is about what would pass through a $\frac{1}{8}$-in. round hole, which is far from the 200-mesh to grind when used in the ordinary pulverized-coal burner. It is not necessary to dry the coal before grinding. I have great hopes for the device, and I think that it may be so arranged by perhaps using a little larger size of coal than now contemplated, and get a supply for it by merely passing the screenings over a plate with, say, $\frac{3}{16}$-in. round holes. If that could be done it would greatly simplify the so-called pulverized-coal problem. The furnace was about 3 ft. internal diameter and would burn, say, 3000 lb. of coal an hour.

The Chairman—It was under a 250-hp. boiler and gave 150 per cent. rating at about 81 per cent. boiler efficiency.

W. L. Abbott—Professor Young, of Purdue University, has made tests on it which will be published soon. He reports a remarkable efficiency. That is, above 70 per cent., which is very high for our ordinary Illinois coal; a high ash is no deterrent to the system, as it has no ordinary furnace. The ash goes in with the coal and eliminates itself by melting and running out.

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*From report of the Prime Movers Committee, National Electric Light Association, and discussion at convention.

Lockett Flat-Flame Oil Burner

When using the grades of crude oil having a heavy residuum, it is necessary to have a burner adapted to handle that class of fuel. Essential features of a good oil burner are simplicity, easily and cheaply renewable parts, economy in the use of steam for atomizing and the production of a flame that will make good combustion and high boiler efficiency possible.

To meet these requirements, A. M. Lockett & Co., Ltd., 533 Baronne St., New Orleans, La., have developed a burner of the fishtail-flame type. The only wearing part is the tip, which is made of steel, is cheaply renewable and has a long life. It can be cleaned easily by removing one plug. The oil pipe is straight and, if it becomes carbonized, can be cleaned without dismantling the burner, and it is provided with a steam bypass for blowing out the tip and strainer when shutting down. The burner is shown in Fig. 1.

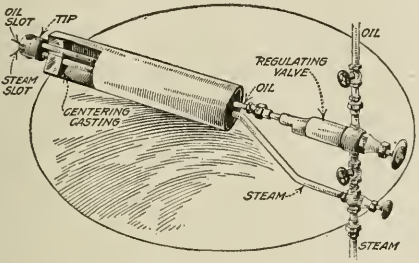


FIG. 1. FLAT-FLAME OIL BURNER

A regulating valve, used with the burner, is shown in section in Fig. 2. Oil is passed through a strainer in the regulating valve and therefore the oil feed is regulated after it has been strained. By discharging the oil through a slot instead of a ring, which gives an opening greater than the holes in the strainer, any dirt that passes through this strainer will pass through the opening. The strainer is easily removable for cleaning and can be quickly changed. The burner gives a flat fishtail flame, which means that it is possible to distribute the air for combustion uniformly over the whole area with a minimum of excess air.

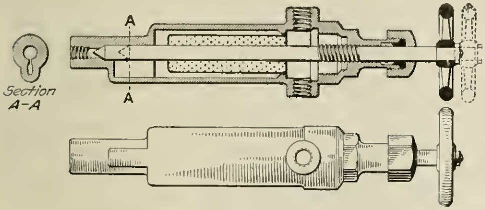


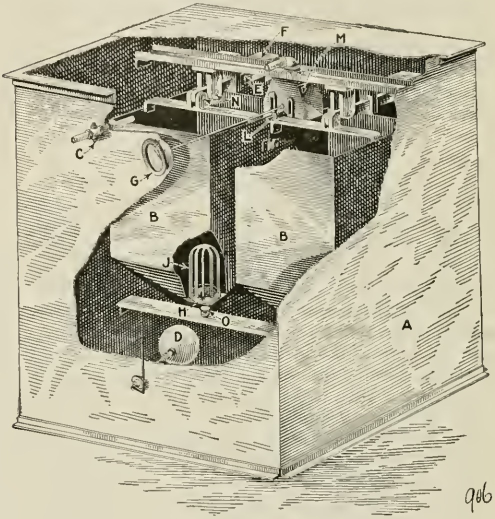
FIG. 2 OIL-REGULATING VALVE

Turner Automatic Water Weigher

The illustration shows an automatic water weigher that is manufactured by the Water Weighing Machine Co., Inc., Piqua, Ohio. *A* is the steel storage tank, *B* and *B* are cast-iron rectangular weighing buckets having hopper bottoms and open tops; *C* is the water inlet from the heater or other supply; *D* is a float and valve that maintains a constant water level in the storage tank; *E* and *F* are a scale beam and counterweight, the beam having knife-edge bearings at *N*.

In operation the water enters through the supply pipe *C* (shown broken) and flows into the bucket, which is held in its upward position by the weight *F*. If, say, the bucket is designed to weigh 100 lb. of water at each discharge, water will flow into this bucket until it contains 100 lb., when the weight of the bucket and water overcomes the counterweight *F*. The bucket then descends and as it does so it pulls down the lever *L* and this moves the valve *M*, causing the water to flow into the other bucket.

As the bucket descends it causes the round bronze valve *H* to strike the stop *O*. This valve has a bevel bronze seat. The ball valve *H* is held on its seat by the static pressure of the water. As it strikes the stop *O* the descent of the bucket causes the stop to push the valve off its seat, when its buoyancy causes it to rise to the top of the cage *J*. Water then pours out of the bucket through the valve opening, and after a small quantity has been discharged, the counterweight again slowly comes down to its normal position, but the water continues to discharge, and as soon as the level of the water reaches the valve, it then slowly descends and seats by gravity. When the other bucket fills, it operates in the same way, and as each bucket empties, it actuates the recorder *G*. An outlet at the bottom ordinarily connects with the pump suction.



SEMI-SECTIONAL VIEW OF WATER WEIGHER

This machine is easily calibrated; all that is necessary is to set the counterweight out on the end of the beam and pour into the bucket the exact weight of water it is designed to weigh at each discharge. This water must be weighed previously on scales known to be accurate. Then slowly move the counterweight along the beam until it just breaks the balance, and set the weight fast by a setscrew. The weigher is then ready for operation. The top is movable and can be removed and the operation observed at any time.

These machines are built in sizes from 6000 lb. to 48,000 lb. per hour maximum capacity, and larger sizes can readily be built.

Unusual Causes of Racing of Ammonia Compressors

By E. W. Miller

In one case dry compressor valves, sticking at one extreme of travel, caused racing; in another a valve disk in the suction line worked loose, shutting off the flow of gas to the machine. Another compressor raced when the springs holding a false head in place broke, allowing the head to lift from its seat.

RECENTLY one of the ammonia compressors in our plant began to give considerable trouble because of racing. The machine was a 100-ton Boyle, having two vertical double-acting compressors with the engine vertical and set between the two compressors. Sometimes it would run along for a number of days without trouble, and then it would suddenly start off and race until the safety cams operated and shut down the engine unless someone happened to be near and managed to close the throttle. This happened a number of times; the governor, the whole machine in fact, was examined without finding the cause of the trouble.

Being somewhat at leisure one Sunday, I decided I would stick close to the outlaw during the day, particularly as it had shown indications in the morning of starting its regular capers. For the greater part of the day nothing happened. I was oiling the valve gear of the engine on the deck of the machine when trouble started. First the machine would speed up and then suddenly slow down until the valves on the engine failed to unhook. Then it would speed up again at a greater rate before it would swing to the other extreme and slow down. The throttle was closed enough to hold the speed down to a safe limit. I then had one of the assistants watch the throttle while I investigated the governor. This was in perfect condition; even the plates on the hooks and arms of the valve gear were in excellent order. These in many cases had caused similar troubles before. but not so in this case.

Sticky Valve Stems Cause Trouble

While I was examining the engine valve gear, an unusual slam in one of the compressors attracted attention. As near as could be judged it was a valve slamming down on its seat. At the same time the machine nearly stopped. With this as a clue I found a convenient box and settled down for a still watch for trouble. The wait was not long. The moment the machine started its capers gas could be heard whistling through one of the valves, and by a few smart raps on the cage the trouble was corrected before the man watching the engine could get to the throttle. Evidently, a valve was sticking.

When we removed the bonnets of the top valves of the compressor, it was found that the valve stems were dry and covered with a rather hard, sticky substance; this evidently had caused the valves on the top of the cylinders to stick at times and possibly on both compressors at the same time in some cases. It is presumable that when one of the valves stuck and unbalanced one of the compressors and the machine began to speed up, this intermittent action of the valves caused them to open more violently and move farther than normally, causing both to stick for short periods. If one or both valves let go at the same time and resumed normal operation while the machine was running at high speed and the governor at the top of its travel, it would slow the machine down so much that the safety cams would act and shut it down altogether.

The sticky substance was made up of oil and dirt, and when the discharge gas was very hot they baked on the valves and stems. It was apparent from the appearance of the stems that little oil reached the valves, as they were practically dry and had a high polish in places. There was reason for this as the oil supplied to the machine was applied to the stuffing-box lantern and of course all the oil that got into the compressor was that carried around the system and that which was carried into the cylinders with the piston rods. The oil that was drawn in by the piston rods went only to the bottom valves and that drawn in from the system went the same way, as it would naturally drag along the bottom of the pipes and go to the lower end of the machine where the branches to the suction valves were made

To remedy the trouble we first cleaned the valves and stems with gasoline and put them back in place. We then found two pressure oil cups that formerly had been used on the lanterns of the machine and drilled holes in the valve bonnets and connected the oil cups into them. By regulating the feed to about two drops per minute, the valves got plenty of oil and no further trouble was experienced.

Valve Disk in Suction Line Worked Loose

In another case one of the machines began to run away without any apparent reason. Everything would be going along nicely when, without warning, the machine would speed up at a rate that made it necessary to shut it down. This happened two or three times; the most thorough investigation failed to show anything wrong.

One day one of the engineers happened to be looking at the suction gage at the moment the machine went speeding. To his surprise the pressure went down to about 20 in. vacuum in a few moments. Here, evidently, was a clue to the trouble. Some place or somehow the line was shut off, and of course with no gas to pump there was no load on the machine, and it naturally got frisky. In the meantime one of the oilers had stopped the machine and started it again. The suction pressure had returned to normal a few moments after the machine stopped, and when the machine was again started it remained at normal, thus indicating that whatever the trouble was, it had disappeared when the machine was stopped.

Some of the crew wanted to pump down and investigate the machine from stem to stern, but one of the assistant engineers insisted that the trouble could not possibly be in the machine because machine trouble would not cause the suction pressure to drop in the manner described. The force then directed their attention to the suction line. About 25 ft. back from the machine was a stop valve in the suction line, placed in horizontal position. Someone suggested that this valve might possibly stand investigation. So the line was pumped down and the bonnet of the valve removed. A glance was sufficient to disclose the cause of the trouble. The valve had been placed in the wrong position, and the flow through it had a tendency to close the valve against the seat. The disk had worked loose from the stem, and as the valve was of the globe type and lying on its side with the stem extending out in a horizontal position, the disk had been dropped to such a position that with a sudden rush of gas through the valve it would swing against the seat and the pressure would hold it in place. As soon as the machine was shut down there was sufficient leakage past the valve to fill the line again, when the disk would drop back to its regular position. To prevent further possibility of trouble from this source, the valve was reversed so as to bring the flow of the gases against the bottom of the disk, which would tend to open instead of close the passage in case the disk should be dropped at some other time.

COMPRESSOR RACED WHEN SPRINGS BROKE

In another case a 150-ton vertical York compressor developed a serious case of racing. It would run along well for a few minutes and then start to cut up capers for a few revolutions. As usual, we did everything possible to the governor and valve gear of the engine but without results. The next move was to look into the valves of the compressors. We found nothing wrong in the first compressor, but got no further than the removal of the cylinder head of the second before we located the trouble. Four of the heavy springs holding the false head in place had broken, allowing the head to lift from the seat. At this time it had evidently got caught while partly cocked to one side, with the result that it had failed to seat at all, and of course the gas rushed back into the cylinder as fast as the piston went down. This is most likely what happened before when the machine began to race. Anyway, after putting in new springs in place of the old ones we had no further trouble.

Performance Tests of Economizers

By B. M. Baxter

Although economizers have been in quite general use for a considerable number of years, there has been a marked increase in the size and number of installations in the last few years. This has been due to two or three causes. The increased price of coal, which emphasized the fuel-saving advantages of the economizer; the development of the forced-draft underfeed stoker, which has made possible driving boilers at much higher rates than formerly; and the use of higher steam pressures and the consequent increase in the minimum flue-gas temperature, due to the necessary difference between steam temperature and flue-gas temperature for an economical rate of transfer of heat from the gases to the water in the boiler.

This increased use of economizers makes necessary some standardized method for conducting and reporting economizer tests and economizer performance.

The important factors entering into the design of an economizer to fit any given set of conditions are the rate of heat transfer from the gases to the water and the draft loss and also, to some extent, the efficiency. The first of these determines the heating surface necessary for the desired results; the second, the arrangement of the heating surface and the amount of free area between the tubes necessary to be provided to avoid undue resistance to the flow of the gases, or, expressed in another way, loss of draft. The third also affects the performance through determining the percentage of the available heat of the gases which can be counted upon to be absorbed by the feed water.

It is known that the rate of heat transfer from the gases to the water is materially affected by the velocity of the gases through the economizer. Hence, for the most economical design it is essential that as high velocity of the gases be obtained as the conditions of the installation in question will permit, thus obtaining the maximum return on the investment in the economizer. However, the increase in gas velocity causes a great increase in the resistance to the flow of the gases, or draft loss. Many economizer installations in the past have been faulty through failure properly to anticipate the draft loss, and it is in connection with the calculation of draft loss that present knowledge of economizer performance is incomplete.

CALCULATION OF DRAFT LOSS

The necessity of well-established rules for the calculation of draft loss is particularly evident in connection with economizers designed for operation with natural draft, as the proper proportioning of the economizer to the chimney is an operation requiring great care. If the heat absorption of the economizer is greater than calculated, the draft created by the stack will be less; and if at the same time the draft loss through the economizer is materially greater than calculated, the furnace draft may easily be too low to operate the boilers at the rate needed. With induced draft a lower temperature of gases leaving the economizer than calculated is beneficial, as the gases are denser and can be moved at a lower fan speed. Also, in induced-draft fan design it is easy to provide for sufficient variation in draft requirements to take care of any probable error in the method of calculation of draft loss, but it is desirable to have better data than at present available in order to avoid the expense that is incidental to provision of this kind.

The adoption of a standard method of making and reporting economizer tests and the publication of such tests so made would soon afford sufficient data from which to prepare accurate formulas covering all phases of economizer performance. All things have a beginning, and it is with the hope of making a start toward the adoption of such a standard method that the following form is proposed:

FORM FOR REPORTING ECONOMIZER TESTS

1. Date of test.
2. Type of economizer, parallel flow or staggered tube.
3. Length of tubes.
4. Number of tubes per section.
5. Number of sections.
6. Square feet of heating surface, builder's rating.
7. Square feet free area between tubes.
8. Duration of test in hours.
9. Total amount of water passed through economizer

10. Average rate of flow of water through economizer, pounds per hour.
11. Average temperature of water entering economizer, degrees F.
12. Average temperature of water leaving economizer, degrees F.
13. Average temperature rise of water in passing through economizer.
14. Average temperature of gases entering economizer, degrees F.
15. Average temperature of gases leaving economizer, degrees F.
16. Average analysis of gases: Carbon dioxide, per cent.; carbon monoxide, per cent.; excess oxygen, per cent.
17. Pounds of flue gas per hour passing through economizer.
18. Average velocity of gases through economizer.
19. Average draft at entrance to economizer.
20. Average draft at exit from economizer.
21. Average draft drop through economizer.
22. B.t.u. transmitted per hour per square foot of heating surface.
23. Mean temperature difference between gases and water.
24. B.t.u. transmitted per hour per square foot of heating surface per degree mean-temperature difference. (Coefficient of heat transfer.)
25. Specific heat of gases. (State whether assumed or calculated.)
26. Efficiency. (Ratio of heat absorbed by water to heat lost by gases.)
27. Draft loss per section.

The purpose of items 1 to 15 needs no explanation. The analysis of the flue gases is necessary in order to calculate the weight of flue gas passed through the economizer, and in addition to the flue-gas analysis it is necessary to record the amount of fuel burned under the boilers operating in connection with the economizer and, if possible, the carbon content of the fuel. If an ultimate analysis of the fuel is not available, a close approximation can be made, if the mine from which the coal is obtained is known, and by reference to analyses of the Bureau of Mines.

The figure for the B.t.u. transmitted is obtained readily from the temperature rise of the water, but the calculation of the heat lost by the gases involved either an assumption of the specific heat, which is usually considered as 0.24, or a calculation of the specific heat based on the proportions of carbon dioxide, carbon monoxide, oxygen and moisture.

The weight of the flue gas passing through the economizer is also determined from the gas analysis. This figure is desirable as it appears that there is a definite relationship between the weight of gas per foot of tube, the mean-temperature difference between gases and water and the coefficient of heat transfer.

The draft loss through the economizer depends both upon the velocity of the gases and the number of sections. Presumably, the draft loss should vary as the square of the velocity and directly as the number of sections.

The mean-temperature difference between gases and water may be determined approximately by the subtraction of the mean of the entrance and exit temperatures of the water from the mean of the entrance and exit temperatures of the gases, but more properly and more accurately by calculation from the logarithmic formula,

$$\textit{Mean temperature difference} = \frac{ITD - FTD}{2.3 \log \frac{ITD}{FTD}}$$

Where

ITD = Initial temperature difference = temperature of entering gases minus temperature of water leaving.

FTD = Final temperature difference = temperature of gases leaving minus temperature of entering water.

Reports of tests of economizers made according to the preceding form would soon afford sufficient data for more accurate economizer design than is now possible and prevent repetition of errors which have been frequent in past economizer installations. They would also be of great value in comparing the operating results of present installations and in determining whether the results obtained were the best possible, through establishing some basis of comparison.

For tests wherein all the foregoing data cannot be obtained, item 16 may be omitted and by the assumption of an efficiency figure for item 26 (usually taken as 85 per cent.) and of the specific heat of the gases (0.24) the weight and volume of flue gases can be calculated and approximate results obtained as accurate as the assumptions used and at least fairly comparable with other similar tests.

A Pneumatic Steam-Turbine Governor

Practically all governors heretofore used, either on engines or turbines, depend upon the centrifugal force of metal balls or weights opposed by springs or weights, combined with other mechanism, to operate the valves. In a new type of pneumatic governor, designed and now used by the Ridgway Dynamo and Engine Co., of Ridgway, Penn., the distinctive difference is that air replaces the metal balls or weights and also replaces the connecting linkage levers, etc., between the centrifugal element and the valves.

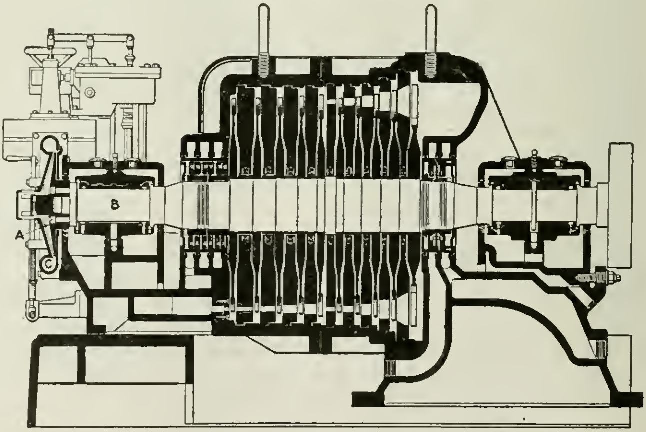


FIG. 1. APPLICATION OF FAN IMPELLER TO THE TURBINE SHAFT

Referring to Fig. 1, a small fan impeller *A* bolted to the end of shaft *B* is inclosed by the fan housing *C* and generates an air pressure of about 12-in. of water at

3600 revolutions. This air pressure acts on the under side of two light aluminum pistons *D* and *E*, Fig. 2, forcing them upward. This movement is opposed by the spring *F*. At the upper end of the piston rod *G* the lever *H* operates the pilot valve *I*, which admits oil to and from the cylinder *J*, the piston *K* of which operates the main inlet valves, *L*, *M* and *N*, *N* being an overload valve. The spring *O* is for the purpose of closing the main valve in case the oil pressure should fail for any reason.

A synchronizing motor *P* is for adjusting the speed from the switchboard. *Q* is a worm on the motor shaft and *R* is a worm wheel which engages with the handwheel *S* by means of pin *T*. The speed may therefore also be adjusted by hand with the wheel *S*. An electric contact *U* is for the purpose of breaking the circuit in case the motor is run too far in either direction.

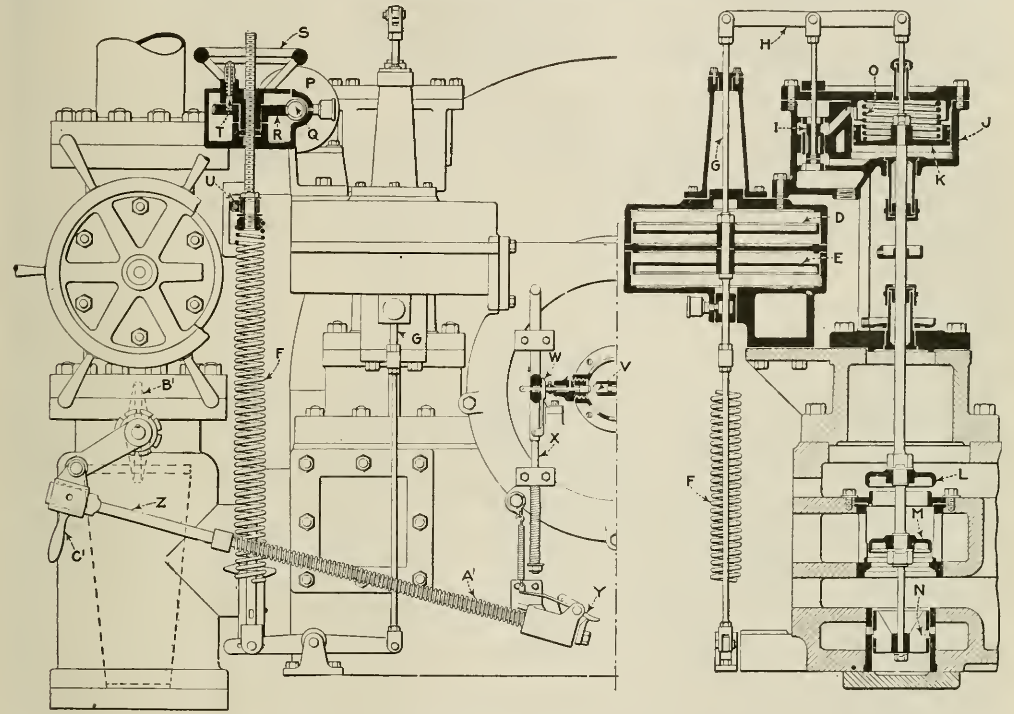


FIG. 3. DETAILS OF THE PNEUMATIC STEAM-TURBINE GOVERNOR

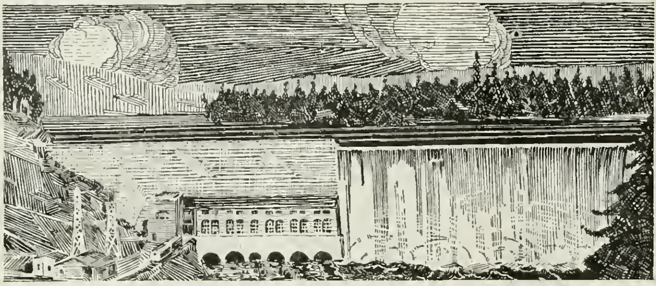
The hub of the fan impeller *A* has a spring bolt *V*, for operating the emergency trip. In case of overspeeding this bolt *V* strikes the hair trigger *W*, releasing the hammer *X*, which in turn strikes the main latch *Y* a blow, releasing the rod *Z* which, due to the spring *A′* closes the butterfly valve *B′* in the steam line. Handle *C′* is in the form of a loose toggle, the lost motion of which permits some movement of *Z* before a movement of the bell crank takes place; thus the inertia of *Z* under movement is used to start the butterfly below the throttle valve.

The pneumatic governor has many advantages. The only running part is a plain disk, with vanes on the side of it, which is bolted to the end of the shaft. Air forms the connecting medium between it and the other moving parts, and these move only on a change of speed due to a change of load. The small pilot valve *I* and piston *K* move in oil and should therefore last indefinitely. The governor as a whole is simple and little subject to wear. The only work to be performed by the air pistons is to operate the small ⅝-in. diameter pilot valve, which is balanced and floats in oil. The air force on these two pistons is about 150 lb. The pneumatic action is therefore quite powerful and reliable. The air pressure generated by the fan is as the square of the speed, and slight change in speed, therefore, is quick and effective in its action.

Oil is used in the power cylinder *J* because it acts like an oil dashpot, preventing jumping, overtraveling or hunting of the main valves, and at the same time it insures long life to these parts. Oil for the operation of the governor is supplied from a branch off the oiling system for the bearings. The conditions of atmosphere may slightly change the speed of the turbine, but these are so slight as to be negligible and need not be considered.

If the boiler horsepower is given, and the chimney height (H) is assumed, the required effective area (E) in square feet of a chimney may be found by the formula, $E = \frac{0.3\,hp.}{\sqrt{H}}$

For round chimneys the actual diameter should be the diameter of the effective area plus 4 in., and for square chimneys each side should be the side of the square of an area equal to the effective area (that is, the square root of the effective area) plus 4.



POP'S WATER-POWER COURSE

By
John S. Carpenter

JIMMY came in from the cold outside, where the wind blew a young gale, and walked over to Pop's buffet while the good-hearted old chief watched him with a paternal eye.

"So you've got a bad attack of housemaid's knee, hey? Better keep them kind of wimmen off yer knee. But don't look at me like that. Go to it, jes' so you don't git to seein' double. And say! I got the purtiest little turbine drawed up in section that you ever saw!" Pop proudly displayed Fig. 1.

"Why, Pop," said Jimmy, engulfing one of Pop's long black cigars and lighting the half that projected from his face, "you've got such a good sketch there that you don't need any explanation to go with it. I can see all I want right there."

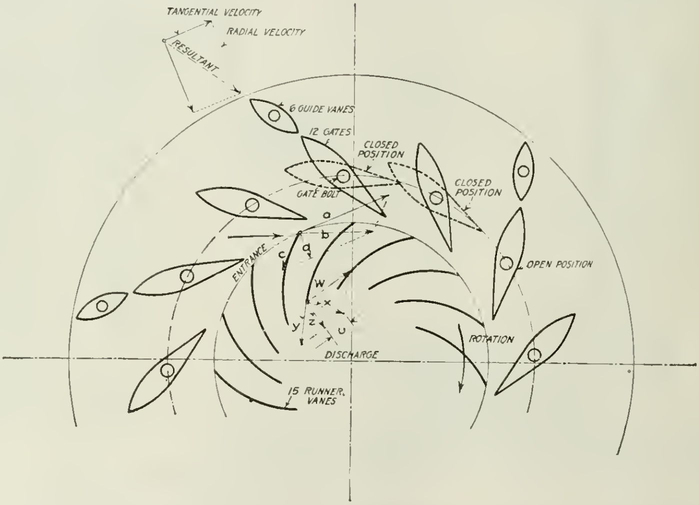


FIG. 1. HORIZONTAL CROSS-SECTION OF IDEAL TURBINE

"You can see a lotta things now that you couldn't before you got a strangle hold on that bottle," retorted Pop. "Now git this, son; the only law that amounts to a darn in turbine-runner design is 'Shockless entry and discharge without velocity.'"

"Pop," crowed Jimmy, "no lawyer ever put that into words. Where's all the whereases and whereins? Can you prove that the party of the first part is not pro bono publico in dutcho with the party of the second part?"

"Aw—fergit it. That buffet gits locked up from now on. Now, as I was sayin', so fur as efficiency and power output goes, our lecturer tol' me that he could develop the whole turbine theory from that law. Shockless entry means—er, jes' what it says—that the water gits in, or enters into the turbine without shock. What I means by shock is showed very purty by tryin' to slide your hand along this polished table top by bringin' it down with a bang, instead of by goin' to it and doin' what you want to do, slidin' your hand along it in the first place."

"Can you give me another horrible example from daily life?" inquired Jimmy, slowly getting back to normal.

Pop thought a minute; then he snapped: "S'posin' you tol' Annie, the peach over at the Greasy Spoon Beanery, that she was as ugly as that bullpup I got, and then ast her fer another settin' of them free hot rolls. She'd like you and electrocution the same way. But s'pose you go after it like this, with a dollar's worth of cold cream on every word: 'Say, Annie, when they gave out the good looks you was in the bald-headed row an' got 'em all. Would you mind slippin' me another roll or so?' Then she'd give you all that wasn't nailed down."

"You're fulla that stuff, Pop, but I see what you mean. You mean that the water, to be in the best condition to do work, should enter the turbine without shock, which means not to turn it out of the natural path it would follow. Now let's begin with those things that you mark guide vanes on your sketch. Let me see if I can explain it alone. The water comes around the turbine, which is situated in the scroll case, and has two motions—one that is very nearly tangential to the turbine case, and another that is toward the center of the turbine, or radial. To get in without shock, the water must follow a combination of those two movements—what the highbrow fellows call 'the resultant of the two forces.'"

"Fine," exclaimed Pop with no little admiration. "It's not so easy to git them fine points at the first try. But you forgot to say that the resultant path of the two motions is the angle that the guide vanes should be set at. Now we'll take up the next thing I got marked as wicket gates on my sketch. The guide vanes and the wicket gates form a sort of circ'lar path that the water takes and which should happen at about three-quarters load on the turbine, at which load most correctly designed turbines have their maximum efficiency. For the newest and highest-speed turbines this isn't exac'ly so, the high point of efficiency bein' nearer full load. The gates, by swingin' on this pivot which I calls a gate bolt, opens up more or less on the narrer end, so lettin' more or less water into the runner and—now git this — by so doin' changes the velocities in the runner a great deal. They is gen'ly half as many guide vanes as wicket gates and mos' always two or three more vanes in the runner than they is wicket gates, the reason bein' that if they was the same number of gates as vanes, they'd be a place in every revolution where the ends would be together, that tendin' to set up vibrations in the machine."

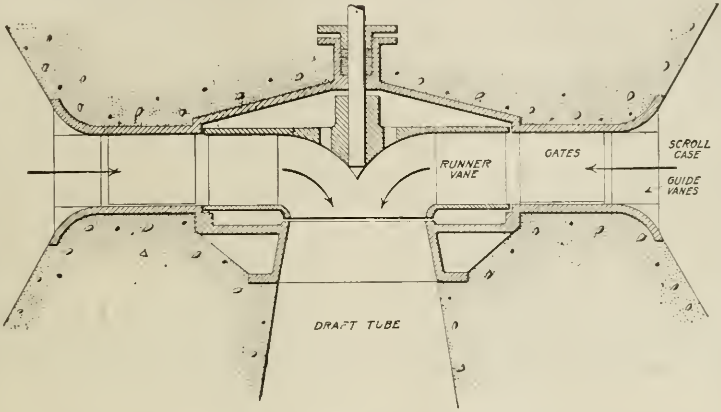


FIG. 2. VERTICAL CROSS-SECTION OF IDEAL TURBINE

"Now, Pop, what's this triangle business here on the entrance to the runner?"

"You mean them things I got marked *a*, *b*, *c* and *d*? Each one of them represents a velocity drawed to some convenient scale. Now *a* is the peripheral speed of the runner in feet per second. In practice it runs from 60 to 95 per cent. of the spoutin' velocity, the mos' ordinary bein' from 75 to 85 per cent. The velocity *b* is the absolute, or really the true velocity of the water enterin' the runner. This velocity varies a hull lot on the different makes of turbines, seemin' to depend more or less on the age and disposition of the boss patternmaker in some cases. We're goin' to see how to do it right, soon. Velocity *c* is the relative velocity of the water to the runner, taken as if the runner was standin' still."

"Relative velocity? What's that? A cousin or uncle by default or something to absolute velocity?"

"S'posin', son, that you was on a train goin' five miles per hour——"

"Now you're talking about the speed records on the Erie or the D. T. & I.," interrupted Jimmy.

"Aw, shet up a minit! S'posin' you was on a train breakin' its neck goin' five miles an hour and you was up at the front end walkin' toward the back at the rate of three miles an hour. Now then, the absolute velocity of the train with respect to the earth is five miles per hour, and the absolute velocity of you to the train is three miles an hour. But git this, kid—the relative velocity of you to the earth is two miles per hour. You're really runnin' backward at the rate of two miles an hour so far as the earth is concerned. You subtracts the speeds in this case 'cause you're goin' in different directions. The three miles you travels backward with respect to the train cancels three of the five miles that the train's goin' the other way."

"And if I was goin' the other way, Pop, I suppose that we'd add the velocities."

"Correct; the three miles you're goin' adds so much to the train speed, making eight miles per hour. Ag'in, if you was runnin' ten miles an hour backward an' the train was goin' ten miles forward, then you'd be standin' plumb still with the earth even though you was ashakin' your ol' bones like the devil to keep up. Git that?"

"U-huh," mumbled Jimmy. "So now you use the same idea on velocities of the turbine runner, and *c* found by those diagrams is the relative velocity of the entering water to the runner vane."

"Yep. I see, Jimmy, that the alcoholic fog is clearin' off," observed Pop with a twinkle in his kindly eyes. Jimmy pretended not to hear the jibe.

"Are the other velocities, *b*, *c* and *d*, any fixed proportion of the spouting velocity, like the velocity *a*?" inquired Jimmy, relighting the cigar butt.

"Yep, but one thing I wants you to git is that each manufacturer makes his turbines to suit his own dear little self and tells the other fellers the place to buy through tickets to, no stop-over allowed. So the standard makes of turbines is about as much alike as a boy-cow and his brother. You can see from them two diagrams that they is at least five things that you can change, and each one makes all the others change. Then, as regards the shapes of the runners, they is as near to bein' alike as Paris styles in two seasons runnin'. If ol' man Bill Shakespeare did turbine designin' fer a livin' instead of takin' real money fer writin', he never would have wrote that purty limerick entitled 'Variety is the spice of life' the way he did, them words bein' by hisself, the moosic by accident."

"How would he have said it, Pop?"

"Oh, he'd 'a hollered, 'Standard turbines is life's chow-chow.' "

The two gravely lighted fresh cigars (from Pop's box) and bent over the table anew.

"Regardin' the discharge side of the runner, so fur as them velocity diagrams is concerned, pretty much the same spiel goes. The velocity *w* is the peripheral speed of the runner at that point, *y* is the relative speed of the water to the runner vane, *z* is the vertical component of the absolute discharge velocity of the water with respect to the earth, and *x* is the true absolute discharge velocity of the water. Now, see that line marked *u*?

That is the amount of velocity that the water has in a tangential direction, and it is jes' this that makes the water go on down through the draft tube in a spiral path. They is a point on the load curve of every turbine where x and z will fall in one line and the line will be at right angles to w. At that load the water will come out of the turbine without any twistin'."

"I've got a hunch, Pop," exclaimed Jimmy. "Now am I right when I say that when the gates open or close, the water velocity in the runner is changed and that swings x to the left or right, as the case may be, because y changes in length?"

"Yep, that's it. When y is quite small the water goes down through the draft tube with a hull lot of twistin' an' keeps agoin' even after it's out in the open stream, a-boilin' and makin' great big bubbles," said the old man.

"Tell us, Pop, what percentage of the spouting velocity z is."

"I tol' you before that it ain't the same on any two makes of turbines, but good designers is fairly well agreed that in what they calls slow-speed runners it's about 3 or 4 per cent. of the total head; in what they calls normal runners it's 5 or 6 per cent.; and in the highest speed runner made today it's about 20 per cent. That means that you find 5 or 20 per cent. of the head, as the case may be, and then find the velocity due to that head. The great trick is to make x as short as possible, for then you get discharge practically without velocity."

"That means of course that so much of the head is lost, then?"

"Not by a jugful! By hickey, no! The draft tube, as I told you before, is a great hand fer turnin' velocity back into pressure when they's taper enough to it. You win a red necktie and a rubber collar fer that one."

"How much of the velocity is gotten back in that way, Pop?" asked Jimmy, sheepishly.

"Of course they's friction to count in, too, but they claims that when conditions is right they can get back about three-fourths of the head that is represented by velocity at the runner discharge."

"I s'pose, Pop, that you'll give us another view of the turbine shown in Fig. 1 so that we can study it better?"

"In Fig. 2 I drawed up about what you wants. Now git me when I says that this ain't anything else than a ideal turbine, 'cause them standard turbines is complicated and it's no wonder that self-respectin' turbine designers goes nutty. We'll first take somethin' we can understand, and later we can rush in where angels fear to tread, as the guy says. Git me?"

"Yes, indeed, Pop. I must admit that you're a genius after all, and I don't see how you managed to conceal it so successfully from the world all these years," said Jimmy with a chuckle.

"And now, you red-headed highball hound, before I puts the coffee pot on the stove and gits out the cake and the pinochle deck, let me tip you off to think a bit about how velocities and areas is figgered; 'cause next time we goes into it up to the hubs!"

Methods of Testing Blown Fuses

By E. C. Parham

The frequency with which help is sought for trouble that proves to be only a melted fuse or an otherwise defective one makes it apparent that an explanation of the simple method used by maintenance inspectors for locating a blown fuse might interest those who have trouble of this nature to contend with.

IN MANY cases the test for a blown fuse is to try another; if the new fuse happens to be defective or of too low capacity—conditions that quite often obtain—the next step generally is to call for help. Unfortunately, inspection of an inclosed type of fuse frequently fails to disclose its condition. This, in connection with the carelessness with which discarded fuses are permitted to lie around and eventually to become confused with good ones, may result in conclusions that are misleading. The condition of a fuse may be determined by means of a bell circuit applied as indicated in Fig. 1, in which all devices are named. First hold the test lines together; if the bell rings, the test circuit is all right. Then apply the test leads as indicated in the diagram; if the bell rings, the fuse is intact. A lamp and 110-volt circuit may be used in the same way as the bell and battery.

For testing installed fuses a lamp-test circuit of suitable voltage is most convenient; and the voltage rating of the single test lamp or the sum of the voltage ratings of the several test lamps to be connected in series must approximate the voltage of the circuit of which the fuses are to be tested; otherwise the test lamps may be destroyed. One 100-volt to 125-volt lamp provided with leads (Fig. 2) will answer for testing the fuses of an 85-volt to 125-volt circuit. One 250-volt lamp (Fig. 2) or two 110-volt lamps connected in series (Fig. 3) are suitable for testing on circuits of from 220 to 250 volts. Two 250-volt lamps connected in series (Fig. 3) or five 110-volt lamps connected in series (Fig. 4) may be used on circuits of from 440 to 600 volts.

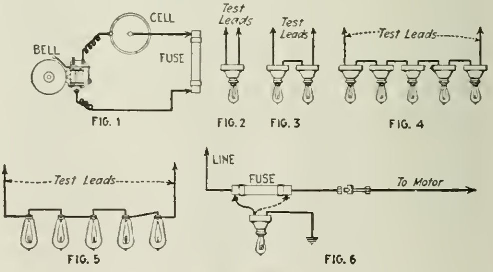


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6

FIGS. 1 TO 6. TEST LAMPS AND CIRCUITS

Where sockets or bases for holding the lamps are not available, the lamp contacts may be connected directly together, as indicated in Fig. 5, and the connections insulated and firmly bound with insulating tape. The lamps should be so connected that both test leads may be soldered to the threaded contact in a secure manner.

Proficiency in tests made with a single lamp or with two or as many lamps in series as the line voltage may require, can be acquired by any operator with but little practice. Fig. 6 indicates the fuse of a ground return circuit of which the ground return conductor includes no fuse. Such a condition is found where the motor frame is grounded and the negative end of the motor circuit is connected directly to the motor frame. Assuming the fuse to be intact and the line to be alive, if one end of the lamp test circuit (here represented by a single lamp) be touched to a grounded part such as the motor's frame, a gas, water or steam pipe and the other end of the test circuit touched successively to the line and motor ends of the fuse, the test lamp will glow. If the lamp glows when the line end is touched but fails to glow when the motor end is touched, either the fuse is "blown" or it fails to make contact with one of its holding clips; inspection will reveal a bad contact.

Fig. 7 indicates the fuses of any two-wire circuit. To make the test first try across the upper ends A and B' of the fuses in order to determine if the line is alive. If the power is up to the fuses, the test lamp will glow; if the lamp fails to glow there exists an open-circuit elsewhere, perhaps a fuse on the service panel at the outer end of the line. Assuming the line to be alive, next test across the lower ends B and A' of the fuses. Glowing of the lamp will indicate the fuses to be intact, because the test-lamp current must pass through one fuse in order to reach the lamp and through the other in order to get back to the line. If contact with B and A' fails to light the lamp, it means blown or otherwise defective fuse or fuses.

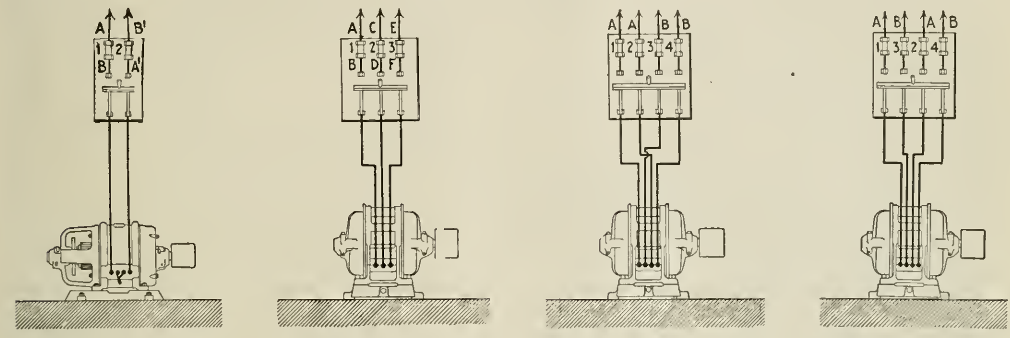


FIG. 7 FIG. 8 FIG. 9 FIG. 10

FIGS. 7 TO 10. SINGLE-PHASE, THREE-PHASE AND TWO-PHASE MOTOR CONNECTIONS

Next test from B to B' and from A' to A; if both tests fail to light the test lamp, both fuses are open. If one test lights the lamp and the other does not, only one of the fuses is blown and the defective fuse will be the one that failed to light the lamp when the test lead was applied to its lower end. Thus, if fuse 1 is blown, the fact will be indicated by "no light" when one of the test leads is touched to its lower end B; and if fuse 2 is blown, this will be indicated by "no light" when one of the test leads is applied to A'. In short when the test lamp fails to light, the test lead on the lower end will point to the faulty fuse.

Fig. 8 indicates the fuses of a three-phase, three-wire circuit. To test the fuses apply the test lamp successively across A and C, A and E, and C and E; if all tests light the lamp, it means that line voltage is up to the fuses. Next test across B and D, B and F and D and F; if each of these tests lights the lamp, it means that all fuses are intact. Assuming, however, that failure of the lamp to light indicates one or more fuses to be blown, hold one test lead on B and test successively to C and to E; then hold one test lead on D and test successively to A and to E; then on F and test successively to A and to C. In other words, successively hold the test line on the lower end of each fuse while testing to the upper ends of the two remaining fuses. When one of these tests fails to light the lamp, the defective fuse will be the one on the lower end of which the test lead rests. And this is true whether one, two or three fuses are gone. In any test that fails to light the lamp the lower test lead will rest on the defective fuse.

The diagram applies also to a three-wire direct-current circuit and to a three-wire two-phase circuit, due consideration being given to the fact that in both cases the number of test lamps to be connected in series must be governed by the voltage between the outside lines.

In Figs. 9 and 10 are indicated the fuses of a quarter-phase circuit. In Fig. 9, fuses 1 and 2 of one phase and 3 and 4 of the other phase are adjacent. In Fig. 10 the phase fuses alternate in order; both arrangements are likely to be found. In either event the test for a blown fuse is the same as that described for Fig. 8 and is based on the easy-to-remember rule that the lower end (motor end) of a blown fuse will not light out with either end of any other fuse in the bank. Therefore, on the lower end of each fuse place one test lead and to the upper end of the other fuse of the same phase touch the other test lead; in any test that fails to light out, the test-circuit lead that is on the lower end will point to the blown or otherwise defective fuse.

In making these tests care should be taken to see that the voltage rating of the test lamps approximates in value the greatest voltage to be tested, and that the insulation on the end of the test leads is removed no farther than is necessary to enable the operator to see what he is doing; otherwise the bared end of a test lead may short-circuit two live conductors and produce a flash that is likely to injure the person making the test.

The Electrical Study Course—A Simple Method of Adding Voltages

Addition of electromotive forces by the use of straight lines as applied to direct voltages is first presented, and this is then developed to embrace problems into which phase difference enters, as in the case of alternating voltages.

In FIG. 1 are represented two storage batteries, a and b, whose voltages are 10 and 4 volts respectively and whose polarities are as indicated. Since there are more cells in a than in b, we could indicate the voltages of the batteries by their lengths, as for example, in Fig. 2. If they were to be connected in series, the total voltage would be 14 volts, and if all the cells were placed in a single case c instead of two separate ones, the length of the case would be equal to $a + b$, as indicated in Fig. 3. The length of c would therefore indicate its voltage.

Suppose, now, that the polarity of b is opposed to that of a, as represented in Fig. 4. If the cells were to be connected in series under these conditions, the total voltage would be 6 volts. That is, the cells in a would be opposed by those in b. This condition is shown in Fig. 5, where the shaded portion indicates the part of battery a that would be required to overcome the voltage of battery b. The result is that we have a battery that is equivalent to the cells contained in the part d.

Instead of showing an entire battery, we could use its base line mn to indicate its voltage. Thus the voltages of a and b in Fig. 2, could be represented by the lines E_a and E_b in Fig. 6. The voltage of both is in the same direction—from left to right—and this fact can be shown by placing arrows at the ends of the lines, as is done in Fig. 6. If the polarities were those of Fig. 4, the arrows would have to indicate the directions shown in Fig. 7. The lines in Figs. 6 and 7 could be combined in the manner indicated in Fig. 8 in order to get the results given in Figs. 3 and 5. Hence, if the voltages are in the same direction, we add one line to the next, and if they are in opposite directions we deduct the shorter line from the longer; the direction of the remainder is that of the longer line.

The method just described works satisfactorily when dealing with direct-current voltages, because these are either in the same direction or diametrically opposed, and so can be added or subtracted without difficulty. In the case of alternating voltages, however, we may have two voltages that make an angle with each other, which alters the conditions. To solve such cases, let us look upon the voltages as forces. We may do so because they are, in fact, electrical pressures. Thus, let us conceive of a weight, represented in Fig. 9 by M, that has two ropes H and K attached to it, by means of which it is pulled along. Suppose that two men pull on H and K in the direction of the arrows, with a force of 120 lb. and 80 lb. respectively, as indicated by the lengths of H and K. Assume, further, that a pull of 120 lb. will move M from a to b in one minute. Then a pull of 80 lb. would move it a distance equal to ac in the same time. Suppose that M has been moved from a to b by the man on H alone, and that the man on K then pulls it alone for a minute. He will move it through the distance a_1c_1 equal to ac, so that the final position will be d, such that $ad = ab + ac$. This is the same position it would have reached if dragged for one minute by the effort of one man pulling with a force of $120 + 80 = 200$ lb., as represented by P. It will be noted that this method amounts to the same thing as the one illustrated in Fig. 8, and the distance moved is proportional to the force. In Fig. 9 ac is made two-thirds as long as ab, since 80 is two-thirds of 120. This is usually referred to as laying the forces off to scale. Thus if we let a length of one inch represent 40 lb. or volts, then 120 lb or volts would be represented by a line 3 in. long, since 120 equal 40×3, and 80 lb. would be represented by a line 2 in. long.

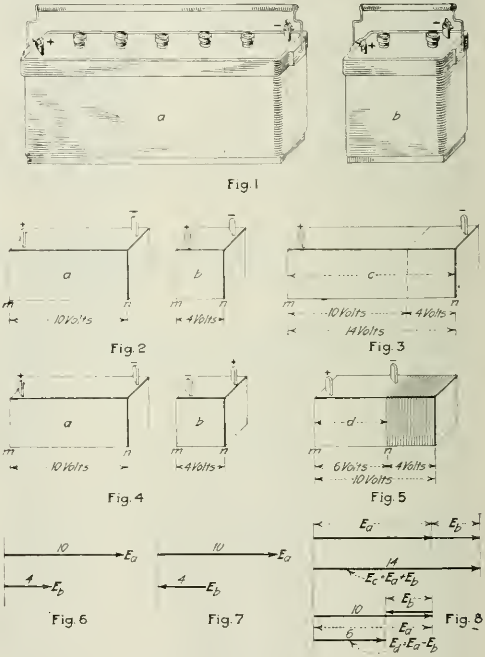


Fig. 1
Fig. 2
Fig. 3
Fig. 4
Fig. 5
Fig. 6
Fig. 7
Fig. 8

FIGS. 1 TO 8. DIRECT VOLTAGES REPRESENTED BY STRAIGHT LINES

Suppose now, that the men separate, so that they pull on the ropes in the directions indicated in Fig. 10. If H pulls alone for one minute, he will move M from a to b. If K then pulls for a minute, he will move M through a distance a_1c_1 equal to and in the same direction as ac, to the point d. The combined effect of H and K for one minute would therefore be to move M from a to d. Hence the sum of the two forces is equivalent to that exerted by a single man pulling with a force P, equal to the length of ad, in the direction of the arrow. In the case illustrated, this force *P* is equal to 126 lb., as can be found by scaling the three sides *ab*, a_1c_1 and *ad*.

What we have really done in the foregoing is to add line *ac* to line *ab*, just as we added *ac* to *ab* in Fig. 9 in order to get the sum *ad*. In the latter case the two forces act in the same straight line, so when we place them end to end they form a third straight line whose length is measured from the beginning of the first to the end of the second. In the former case, however, the forces act in different directions, so that when we place them end to end they do not lie in a straight line, and the sum of the two is therefore not equal to their combined lengths. It is, however, equal to the length measured from the beginning of one to the end of the other—as from *a* to *d* in Fig. 10—just as in the straight-line problem of Fig. 9.

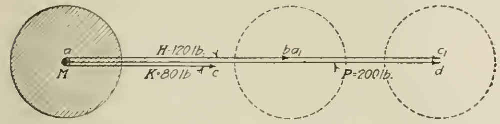


FIG. 9. ADDITION OF TWO FORCES ACTING IN THE SAME DIRECTION

In place of forces in pounds, the lines *ab*, *ac*, etc., could be used to represent electrical pressures in volts. Consequently, if we had two alternating voltages, differing in phase, connected in series, their sum could be found by a construction such as that in Fig. 10. Such additions of forces or voltages are called vector additions, because the lines *ab*, *ac*, etc., are vectors that represent the quantities to be added.

In Fig. 11 curves *A* and *B* represent two voltages 90 deg. apart. The resultant curve *C* is obtained by combining the instantaneous values of curves *A* and *B*. The maximum value of the resultant curve may be obtained by the use of vectors, as shown in Fig. 12. Assume the maximum values of *A* to be 150 volts and that of *B* 100 volts. Then, if a length of one inch is let to represent 100 volts, the maximum value of curve *A* (150 volts) will be represented by a line 1.5 in. long, and the maximum value of curve *B* by a line 1 in. long, at a right angle to the former, as shown in Fig. 12. In this case the side *OA* is made equal to the maximum value of curve *A* and *OB* equal to the maximum value of curve *B;* then, by completing the parallelogram as indicated by the dotted lines *BC* and *AC*, the diagonal *OC* will equal the maximum value of curve *C*, Fig. 11, which in this case is $\sqrt{(150)^2 + (100)^2} = 180.3$ volts. This would also be true for the effective values of curves *A* and *B*.

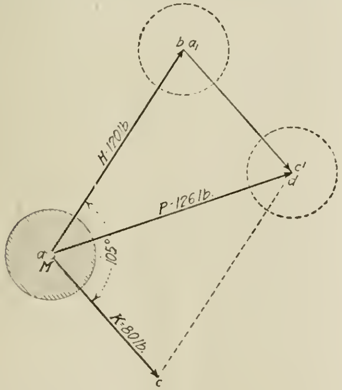


FIG. 10. ADDITION OF TWO FORCES ACTING AT AN ANGLE

As another example find the resultant voltage of two equal voltages 120 deg. apart, as shown by the curves *A* and *B*, Fig. 13. Here it will be seen that the resultant curve *C* is the same as either *A* or *B*. In this problem also, the maximum value of the resultant curve may be obtained by a vector diagram, as in Fig. 14. Here *OA* and *OB* are drawn 120 deg. apart and equal, to scale, the maximum values of curves *A* and *B*. Then the parallelogram is completed by the dotted lines *BC* and *AC* and the diagonal *OC* drawn. In the diagram, Fig. 14, *OC* equals *OA* or *OB*, which checks up with the condition in Fig. 13, where the maximum value of curve *C* is equal to the maximum value of *A* or *B*.

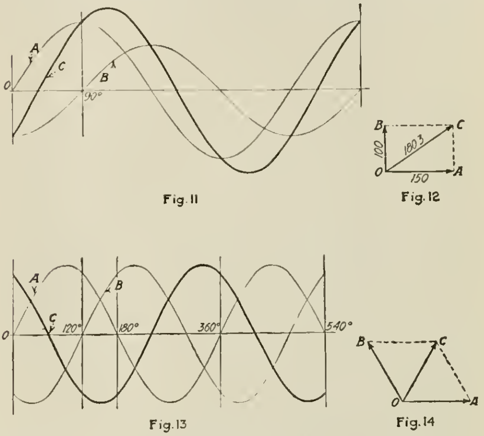


Fig. 11 Fig. 12

Fig. 13 Fig. 14

FIGS. 11 TO 14. ADDITION OF TWO ALTERNATING VOLTAGES OUT OF PHASE

It is frequently possible in alternating-current work to solve easily by the vector-diagram method, problems that otherwise would involve complicated formulas.

The problem of the preceding lesson consisted of determining the effective value of an alternating voltage whose maximum value is 311.13 volts. Also to find the value of the current that it would cause to flow through a resistance of 4.4 ohms. The second part of the problem was to compute the maximum value of voltage of a source that registered 120 volts on an alternating-current voltmeter. From the preceding lesson we know that effective volts = maximum volts × 0.707, therefore in the first part of the problems we have $E = 311.13 \times 0.707 = 220$ volts, where *E* represents the effective voltage. If a resistance of 4.4 ohms be connected across this voltage, the current would be $I = \frac{E}{R} = \frac{220}{4.4} = 50$ amperes. In the second problem we are given the voltmeter reading; this indicates the effective value. We are required to find the maximum value of the voltage. In this case we have 120 = maximum volts ÷ 0.707, from which we get that maximum voltage = 120 ÷ 0.707 = 169.70 volts.

Two voltages, 100, 150 voltages respectively, are are 120 deg. apart from one another. Draw a vector diagram showing what is their sum. What would be their sum if each of them was equal to 100 volts?

The Infringement of Patents

By Chesla C. Sherlock

Generally speaking, the patent laws of this country seek to confer upon the patentee an absolute monopoly of the right to make, use and sell his invention. But in the practical working of the machinery that has been constituted to enforce these rights, many inventors find that a disgraceful situation exists in regard thereto. Infringement of a patent is a constant temptation to established interests, especially when the inventor and patentee is of limited resources, and the chances that the patent will be infringed increase in proportion to the money value of such patent.

Those who are unscrupulous enough to infringe a patent and who are further fortified with ample resources can keep up continuous litigation in first one circuit court and then another, until the patentee is either exhausted in money or patience, or the full term of his patent has expired. This is not a fanciful supposition. It is a situation that exists.

Testing the Validity of a Patent

As soon as a patent is infringed and the patentee charges the infringer of infringement, the latter immediately sets up the defense that the patent was not valid. This, of course, ends in litigation in order to test the validity of such patent. The practice has so grown up that the mere issue of a patent from the Patent Office does not signify anything. The patentee will have to have the courts pass upon the matter before he can rest from his labors with any real assurance. This means a long legal battle, often extending over a period of years. The courts are crowded with cases. Delays arise and one thing or another will often serve to postpone the decision for five or ten years. In the meantime the wealthy infringer is going ahead manufacturing the invention and reaping his profits.

If the patentee succeeds in winning the verdict in that circuit, the chances are that he will have to begin all over again in another circuit and go through the same process. There are eight circuits in the country, and until the patentee has conclusively won or lost in all of them, there is a marked possibility of his finding himself deprived of the just rewards for his invention. A dishonest infringer can thereby comparatively easily reap the profit that justly belongs to another. He can manufacture the invention and sell it all over the United States; he can then attack the validity of the patent and delay the proceedings in one or two circuits the full term of seventeen years during which the patentee is granted an absolute monopoly by the Federal laws. If he loses there, he still has a large share of profits that the patentee was unable to levy on simply because of the system and the machinery that we have established to enforce the patentee's rights.

Very often studied attempts are made by those in competition with the patentee of an important invention to avoid infringement, but at the same time to imitate the successful device so as to be able to meet the competition it offers. But as a rule studied attempts to avoid infringement end in disaster.

Infringement cannot be avoided by a mere variation of form or size or by the substitution of different material. A marked improvement in an essential part must be made if infringement is to be avoided. Contrary to the general opinion, the mere substitution of one part for another or the omission of a minor part in the device will not avoid infringement. If any omission of parts is to avoid the infringement, then such omission must be of an essential part of the device.

The patent grants to the patentee the sole right to make, use and sell the invention for a period of seventeen years. But the manufacture, use or sale of a patented article is not the sole requisite to its infringement. It should be kept in mind that a mere intention to do any of these things is sufficient. One may have the right to do certain things with a patented article, by reason of his agreement with the patentee and still be an infringer of the patent. Suppose that one person is given territorial rights on a boiler for a certain term by the patentee. He has the exclusive right to sell the boiler in the said territory, but he sells a number outside his own territory. He is, by reason of those sales, an infringer of the patent, because he has violated the license granted by the patentee. The same case arises in the use of the patented article. The patentee may limit the uses to which the purchaser or licensee may put the patented invention. If the purchaser violates this limitation, he is guilty of infringement.

As to who may sue for the infringement of a patent, any one of five persons may bring suit, all five standing in a representative capacity of the patentee. They are: (1) Patentee; (2) a sole assignee; (3) owner of exclusive right, in his own territory; (4) executors; (5) administrators. Jurisdiction in such cases is in the United States Circuit Courts and decisions are appealable.

To enforce his rights in case of infringement, it is necessary for the patentee to give notice to the infringer that he is infringing the patent. This must be accomplished as a sort of preliminary step in enforcing the legal rights conferred by the patent, and it is a polite warning to the transgressor to cease his transgressions.

Patented Articles Must Be Fully Marked

Another requisite to enforcing patent rights against possible infringers is that all patented articles must be fully marked. Many manufacturers are content merely to use the term "patented," not caring to convey to the possible infringer information that he would be particularly desirous of knowing, while others are equally anxious to give a full list of all patents and their dates. Some manufacturers even offer to furnish full data to possible infringers concerning their patents.

Where the patent is not given upon an entire machine or device, but is expressly limited to a part or specific parts, a change in the number of parts will avoid infringement of such patent. Thus, if a patent were expressly granted on six parts and a device was brought out with only five parts, the latter device would not infringe the patented one. The same thing is true in cases where a patent has been granted on the form or design of a machine or appliance. But a mere change in form or design will not avoid infringement unless the patent was limited to a particular shape or form.

If repairs are made on a patented machine by one having no license from the patentee, such repairs are an infringement when they change the identity of the machine. The idea is that by repairing the patented machine in such a way as to change its identity the patentee has been deprived of profits justly due him.

It is a general principle that a patent is valid until proved void and that the patentee is entitled to the full protection of the laws to enforce his rights under it, and the tendency to lay them open to the tricks of legal wits should be and is being discouraged on all sides.

EDITORIALS

The Government and the Power Plant

NOBODY begrudges the money that is spent by the Department of Agriculture in the extermination of cattle and plant diseases, the control of destructive insects and the propagation of the many methods which result in an improved and more abundant food crop.

Is there any reason why another appropriate department of the Government cannot do as much for industry?

Is there anything more important than the fuel supply? We had in the shortage of two years ago an intimation of what would happen if it failed. Next to air and food and water, it is the most vital of all the essentials; and yet with what little thought and intelligence and systematic oversight are we rushing it through its wasteful reduction to ashes!

Do we appreciate the part that power plays in modern life—a part so overwhelmingly important that it is difficult to realize that the father of the steam engine has been dead only a hundred years? Imagine for a moment what would happen—or rather, would fail to happen—if the fuel-produced power of the country were to stop. No light, no water, no newspaper, no train or trolley or ferry, no elevator, no motion to the machinery in the shop, and if it lasted more than a few days, no food or fuel in the house.

Power enters into the cost of everything that we buy, of nearly everything that we do. If it is not involved in its production, it is in its transportation and distribution. Is it not of extreme public importance that it be efficiently produced and economically used?

When, under the stress of war conditions, it became necessary to conserve coal and save power, the Government was aroused, and even the hurriedly gotten together organization working under the disturbed conditions of those troublous times produced phenomenal savings by the simplest means. In one manufacturing community some thirty per cent. of the coal used in the industries was saved without interfering with production. This had to be done in war; is it not good to do in peace?

In the Department of the Interior there is an organization already endowed with the authority, if it could be provided with the means, to carry on much of this beneficent work. The act creating that Bureau reads:

> It shall be the province and duty of the Bureau of Mines . . . to conduct inquiries and scientific and technologic investigations concerning mining and the preparation, treatment and utilization of mineral substances with a view to improving health conditions and increasing safety, efficiency, economic development and conserving resources through the prevention of waste in mining, quarrying, metallurgical and other mineral industries; to inquire into the economic conditions affecting these industries; . . . to investigate the mineral fuels and unfinished mineral products belonging to or for the use of the United States, with a view to their most efficient mining, preparation, treatment and use; and to disseminate information concerning these subjects in such a manner as will best carry out the purposes of this Act.

While this may not authorize the direct intervention in the operation of private plants that was practiced to such good effect in war time, it affords a basis upon which the department could do such research and advisory work as is done by the agricultural bureaus; and really in the coal and power crisis it was advice and direction, readily accepted and followed by the power users, which did the most good. One of the most natural and logical commencements for its activities in this direction would be to keep the coal that is shipped from the mines up to a standard of quality or to the specifications of a given purchase. One of the most outrageous economic crimes of the war was the shipping of tons and tons of worthless rock over an overburdened railway system and selling it to the power plants and factories of the country at two or three times the price of good coal. As usual, the consumers of their products had to pay the freight. Unfortunately, the Bureau has not the means to do this work gratuitously for individuals, but it is doing much of it for Government departments, etc., and is better equipped to handle such service than any other branch of the Government. Perhaps arrangements could be made whereby the Bureau would sample and report upon coal shipments at the cost of rendering the service. This activity might naturally lead to an extension of field of usefulness of the Bureau in advising upon and encouraging, if not of insisting upon, the use of fuel and of power with some degree of economy. The cost of wastefulness in this respect is borne by the ultimate consumer, and that is the people as a whole; and the people as a whole, through their Government, ought to have something to say about it.

Pulverized Coal for Boiler Furnaces

PULVERIZED coal again is in the spotlight. Periodically it emerges from back stage, attention is focused upon it and, its latest act over, it goes back again. But each new act is better than the previous one, and the house more crowded with an interested audience. Its progress encourages.

In this issue considerable space is given powdered coal and much of value is told about it. Rightly, the authors lay emphasis upon the necessity of fine pulverization and adequate furnace volume. These are essential to success, for each fine particle must be surrounded with air for combustion and the gases move at low velocity. Neglect to fulfill these requirements has led to the failure of most pulverized coal installations.

Until there is a greater difference in cost between pulverized coal preparation and burning and the combustion of coal on automatic stokers, many engineers will not be won over to it. High-volatile coal makes the best of all pulverized coal. But it is also the most valuable from the broad economic standpoint, because of the hydrocarbon chemicals to be had by distilling off the volatile. It may be several years before anything of considerable volume is done in the way of distilling off this volatile, but sooner or later high-vola-

:ile coal will pass through this kind of a process before it becomes available for power plants, and rightly so. It is nothing short of criminal waste to do otherwise, inasmuch as the heating value is so little lowered.

Of considerable interest is the description of a method of burning ground coal as told by W. L. Abbott, chief engineer, Commonwealth Edison Co., Chicago. The inventor informs Mr. Abbott that the largest size of the coal particles should not be greater than will pass through a one-eighth inch round hole. The particles are, therefore, of large size compared with pulverized coal sizes. It is not necessary to dry the coal before using it. It is burned in a circular furnace, the ash dropping away and solidifying before reaching the bottom of the furnace. The experimental furnace is three feet in diameter and will burn about three thousand pounds of coal an hour. Mr. Abbott says that Professor Young, of Purdue University, who has made a test of it, reports combined efficiencies above seventy per cent., which is high for Illinois coal.

Power Factor in Polyphase Circuits

SINCE the generator, line and transformer capacity required in a given alternating-current system varies inversely as the power factor, and the copper losses vary approximately inversely as the square of the power factor, it is evident that, especially where large amounts of power are involved, power factor of the system is a very important item in the generation, transmission and distribution of electrical power. Putting the foregoing statement into figures, it may be said that to supply a given load at fifty per cent. power factor will require twice the generating and transformer capacity and there will be four times the losses in the transmission and distribution system as to generate and transmit the same kilowatts at unity power factor, not considering the deleterious effects on the voltage regulation both of the generator and the lines. For this reason the power factor has always been of serious concern to those interested in the generation, transmission and sale of electrical energy. There is a pronounced tendency on the part of central-station companies to base their rates for electric power on the power factor of the customer's load. However, before this can be intelligently done there must be some recognized standard definition of and method of measuring the power factor of polyphase circuits.

The power factor of single-phase circuits is easily defined—it is the ratio of the true power as measured by a wattmeter, to the apparent power as obtained with a voltmeter and ammeter; or, as it is frequently referred to, "the cosine of the phase angle between the current and the voltage." However, a definition of the power factor of polyphase circuits has never been agreed upon by electrical engineers. In balanced loads the numerical value of power factor varies but slightly with different definitions, but where the load is unbalanced, with different phase relations between the current and voltage of each phase, considerable variations may be obtained in the power factor when expressed according to the various definitions.

There has been appointed a special joint committee of the American Institute of Electrical Engineers and the National Electric Light Association on the determination of power factor in polyphase circuits. It is the purpose of this committee to establish for power factor in polyphase circuits a definition which shall be universally applicable to all polyphase circuits, whether balanced or unbalanced and which shall satisfactorily take into account the various considerations involved in the commercial and technical uses of the term and in devising methods and instruments for its measurement. The findings of the committee will no doubt be looked forward to with much interest by all those concerned, since, as pointed out in the foregoing, there cannot be an intelligent application of the function known as power factor to the commercial engineering and scientific aspects of the electrical art until some standard definition and method of measurement is adopted.

Andrew Carnegie

LANDED in the cheerful precincts of Barefoot Square, Slabtown, Penn., at the age of thirteen, his father's business ruined by the very development of the industry, put to work as a bobbin boy at twenty cents a day—not a promising outlook. And yet he left a half billion of dollars after spending the last quarter of his life trying to give money away as fast as it came to him, because he deemed it a crime to die rich.

He did not stay long as a bobbin boy; he found he could get more money firing boilers. He saw still better pay and more contact with the world in the life of a telegraph messenger and he got a friend from his old Scotch home to help him become one. And then he took advantage of the opportunity which access to the instruments afforded him to learn telegraphy, and became a railroad operator. There were other messenger boys who did not become operators. One day when his superintendent was away there was a train wreck. Carnegie did what he knew his superior would have done if he had been there and did not shirk the responsibility of signing his superior's name to his orders. The ability, initiative and resourcefulness thus displayed won the appreciative attention of the superintendent, who made the boy his secretary and helped and advised him to make investments which gave him his start in life. There were other telegraph operators, but they did not become multimillionaires. Without that restless reaching out he might have worked in a fireroom all his life. If he had been contented to read cheap novels and talk baseball instead of training hand to key and ear to sounder, he would never have become Scott's operator. If he had spent his let-ups in frivolous day dreams or in watching the clock, he would not have had the grasp upon his superior's duties and methods which enabled him to jump into the breach and make an influential patron of his employer.

In these little things better than in his larger operations can be seen the characteristics which made him the master of iron, of finance and of men.

As an investment proposition the good workman represents a greater risk than a good machine. When the machine breaks down, you can have it fixed up and you still have the same machine which you have learned to make work the way you want it to. When the workman breaks down, you have to spend a lot of time training a new man to work the way you want him to.

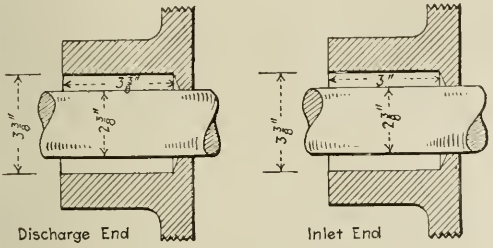
The wise employee asks questions about the work. The other fellow doesn't have to—so *he* thinks.

Correspondence

Send Sketch with Packing Order

I have found it convenient, when ordering packing, to send to the manufacturers a sketch drawn on ordinary cross-section paper. This paper can be bought in 6 x 8-in. pads, which is a handy size for general sketching. It is not necessary to draw to scale, but if all dimensions are given, as shown in the illustration, the chances of getting the wrong size packing are reduced to a minimum. **W. H. Moore.**

Paterson, N. J.



SKETCHES GIVING PACKING SIZE

Concrete Boiler Setting

The description of the concrete setting of boilers at the Robert Gair plant in Brooklyn, on page 934 of *Power* for June 17, recalls an experience that we had with concrete used in boiler-room construction several years ago. We were called to make an economy test of a plant and noticed that a concrete column that had been put up between two boiler settings was disintegrating. As quickly as we could we put in a structural-steel column and beam and removed the concrete structure which was getting ready to crumble.

Concrete is far from fireproof, and it disintegrates under a very moderate sustained heat. A day-in and day-out average temperature of around 110 deg. F., 100 deg. at the floor and 120 deg. at the ceiling, disintegrated that column in about three years. The column stood in a passage between the settings and did not touch either of them. **Robert McLaughlin.**

South Philadelphia, Penn.

Cleaning Handhole Plates

To clean handhole plates of water-tube boilers, place them in a barrel containing water and insert a steam lance, and after adding some caustic soda, boil. The bolts and crabs can also be cleaned in this way, but the threads on the bolts should be oiled as soon as taken from the water. If this cannot be done at once, leave them in the water and see that they are covered; this will prevent them from rusting. **H. M. Botts.**

Peoria, Ill.

Slow Engine Speed and Condensation

In the July 15 issue of *Power*, page 116, under the heading, "Slow Engine Speed and Condensation," I see Franklin Cheney is bothered with the same trouble we had with the engine that drove our stokers.

When the steam pressure was up, a diaphgram valve would check the speed of the engine so that it would just turn over, and then the pipes would fill with condensation, which would be carried to the engine as soon as the speed increased. This caused pounding and considerable packing trouble, and then the water would get in the oil in the crank case.

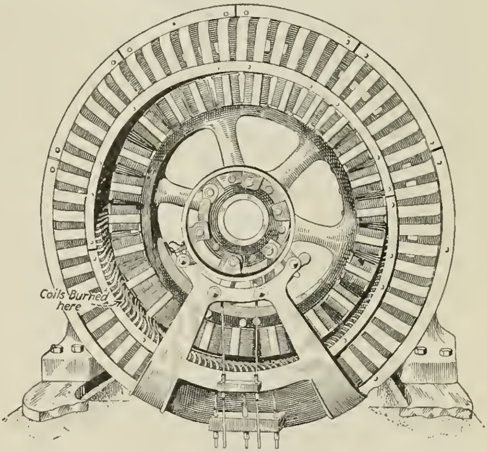
We eliminated this trouble by connecting a steam trap to the valve chest of the engine, which takes care of practically all the water.

Toledo, Ohio. **J. N. Woodruff.**

Burned Generator Laminations Heated

On one of our steam-driven direct-connected generators the frame shifted far enough for the rotor to rub on the stator, injuring the coils at that point. This was possible because the generator frame was not doweled and there was nothing to hold the frame in place when the anchor-bolt nuts worked loose. I first shifted the frame to one side, drove out the wedges holding the coils of the stator in place, which were burned, rewound about ten coils and put in new wedges. When the machine was tried, the laminations got hot at this point in about twenty minutes. Then I shifted the frame over and filed the laminations smooth where they had been burned so that each was separated from the other. After adjusting for clearance, the machine ran just as well as ever.

Vegreville, Alta., Canada. **H. R. Johnston.**



SHOWING WHERE COILS WERE BURNED. BEARING NOT SHOWN

Voltage of Generators Varies When Being Paralleled

Compound-wound generators should have separate equalizer switches for paralleling the series fields and equalizing the current in the series-field circuit before the generators themselves are paralleled. The trouble complained of in the letter, "Voltage of Generators Varies When Being Paralleled," by Mr. Armstrong on page 326 of the Mar. 4 issue, was due to his using three-pole switches on his generators instead of single-pole switches, Fig. 1, or a single-pole and a double-pole switch, Fig. 2.

With the three-pole switch open on the incoming machine, there was no current flowing in its armature, hence its series field was not excited. When the switch was closed on the bus with the running machine, the series fields of both machines were paralleled and the current in the series-field circuit equalized on both generators, energizing the series field of the second machine, raising its voltage and that of the bus, and causing it to take the load until its shunt field was regulated to lower its voltage and the load properly apportioned between the two machines. Similarly, in taking a machine off the line, as soon as the switch was opened the load on that machine was dropped over on the one remaining on the bus; and at the same time the series-field circuit was reduced by one field, causing a drop in the bus voltage until the remaining machine had picked up the load and its series field had raised its voltage. With generators of different capacities this disturbance would be aggravated by putting on or taking off a larger unit than the one running.

The difficulty could best be overcome by replacing each three-pole switch with three single-pole switches. The equalizer bus need only be run between the machines, instead of bringing its cables back to the switchboard, the common practice being to locate both the equalizer switch and the switch on the compounded side of the generator, either directly on the machine frame or on a pedestal close to it. The shorter the run of equalizer cable and the less resistance in it, the better will be the regulation between machines.

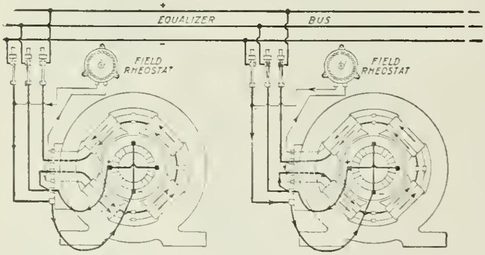


FIG. 1. GENERATORS CONNECTED IN PARALLEL BY SINGLE-POLE SWITCHES

When putting a machine into service with this switching arrangement, the equalizer switch and the switch connected to the series-field winding are closed after the machine has been brought up to voltage. This connects the series-field winding of the incoming machine in parallel with the series-field windings of the machines already on the system. The voltage on the incoming machine is again adjusted to the correct value and the armature switch closed, after which the load is divided among the different machines by adjusting the field rheostats. It should be easy for Mr. Armstrong to saw through the fiber crosspiece of the three-pole switches and convert them into one two-pole and one single-pole switch as in Fig. 2.

With a little experimenting it should be possible to determine the amount by which the incoming machine must be lower in voltage than the bus, in order to compensate for the machine's rise in voltage when its series field is excited. Likewise, in taking a machine off the bus, its ammeter needle should be a shade to the reverse side of zero rather than to the generating side. These are both delicate points, requiring a little study of the actions of each machine; for care must be taken not to lower the voltage of any machine sufficiently to reverse it. FRANK GILLOOLY.

Philadelphia, Penn.

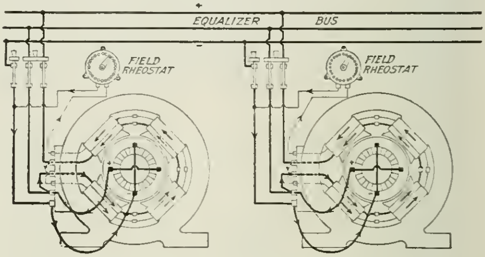


FIG. 2. GENERATORS CONNECTED IN PARALLEL BY SINGLE-POLE AND DOUBLE-POLE SWITCHES

Making Diesel Operators From Steam Engineers

The letter, "Making Diesel Operators from Steam Engineers," by Waldo Weaver, on page 292 of the Feb. 25 issue, is one that manufacturers of internal-combustion engines should take to heart. A well-known manufacturer of a semi-Diesel engine, with whom I have had some dealings, puts out in his literature, as well as through salesmen, something like this: "Our engines are so simple that anyone can operate them, and a high-salaried engineer is unnecessary."

This may be a good selling point, but selling an engine is only the start, and a manufacturer who sells his engine by that method is sure to lose in the long run because the statement is not a fact.

There have been sold thousands of engines in which some part has proved defective, but as a rule the defective part can be replaced or repaired with little expense. The manufacturer who says his engine does not require a first-class engineer to operate it is putting in his engine a defective part that is hard to repair or replace, and it usually costs money to do either. The only exception is where the engine is smaller than 50 horsepower. The engine manufacturer already referred to one time sold an engine to a concern in the ice business to drive an ammonia compressor. The plant as a whole was modern in every detail. A couple of sledge-hammer engineers were hired to operate it, although neither of them knew anything about an ice plant or an oil engine. However, one was a good machinist. The first thing to happen was the cracking of a cylinder head on the engine. A new head was wired for, and a nice little thing weighing a "couple of tons" came by express. It lasted a couple of weeks and then cracked. Another new one was ordered, and at the same time the factory was asked to send one of their experts to run the plant for the rest of the ice season, which they did. The expert knew the oil engine all right, but he did not know what he was pulling with it, and I understand he cracked two more heads before the end of the season. A new head, a new piston and reboring of a cylinder were necessary to put the engine in shape to operate.

To further mess things up, they ordered the piston a certain size and then bored the cylinder. When the bar was set up, they found the cylinder cut out on the lower side only, and to make the new bore fit the piston, they lowered the bar and bored the cylinder one-half inch out of center. This was the condition of things when I took charge. I also found the piston $\frac{3}{16}$ in. too small, and the cylinder being bored off center and the piston of the cone-head type, naturally the piston had no clearance at the bottom of the cylinder head, but at the top there was lots of it. I took away liners from one side of the wristpin brasses and added them to the other side, which shortened the connecting-rod and gave just enough clearance for the piston to miss the head on the scavenger stroke. I ran that plant without trouble through one of the hardest ice seasons the country ever saw and made as much in 21 days as was made during the previous year. This was not because I knew more about the engine than the expert, as I am satisfied he is a good oil-engine man, but was due to the fact that I knew what that engine had hold of and he didn't. He regulated the engine to fit the load, and I regulated the load to fit the engine. His trouble was overload and he didn't know it.

But this owner still thought the engine could be run by anyone, so he decided I was too expensive. However, once or twice each year I get an offer of that same job, and at a salary considerably larger than I was then asking. The plant has made very little ice since then, all due to the fact that that engine was sold with that defective part, "so simple anyone can run it."

Now, as to making Diesel operators from steam engineers: The old reliable steam engineer has an advantage over one who has had no experience with boilers. This advantage is, the operator is careful and is sure he is right before he turns things loose. But he is at a great disadvantage, that the old steam engine has taught him, which is overload. The steam engine is built to use as little steam as possible—that is, as as a rule they are—and to build them to operate economically their rated horsepower is below the real power they will develop. All one has to do to a steam engine of small capacity in order to increase output is to put on the load, and it takes it day after day and year after year.

On the other hand, the oil engine is the most economical in fuel when developing all it will pull. The steam engineer, being used to putting more load on the steam engine than the rated capacity and having experienced no bad results from so doing, tries the same stunt on the oil engine, and this is where he falls down.

A few years ago another engineer and I visited a plant where two 500-hp. Diesels were being installed. This was a steam plant and had three Corliss engines operating. One was a 500-hp. cross-compound. The peak was on and this engine was carrying its steam valves. I called the other engineer's attention to it and made the remark, "A Diesel will never make good in this plant if they try such loads as that on them." Those engines, so I have been informed, have never made good there. I don't know why, but I will bet that the trouble is overload. The steam engineers will be the best Diesel operators if they look out for that overload.

I have never yet seen an internal-combustion engine that I thought should be operated at its rated capacity. I find about 90 per cent. load to be the best. Further, I always advise, "Keep them cool!" I know the expert will kick about "keeping them cool" and 90 per cent. load, and will cry, "Efficiency!" But efficiency cannot be bought with such expensive stuff as cylinder heads, pistons and cylinder liners, shutdowns, interrupted service, etc.

Mr. Weaver has explained that there is no comparison at all between a Diesel and a "flivver." I would ask, How many hours will a "flivver" engine run pulling its full rated capacity? My experience and observations teach me that a "flivver" engine seldom is run at 25 per cent. of its rated capacity on the average. I have never tried it out, but I believe that 24 hours' steady run at full rated capacity will put a "flivver" engine in the shop for repairs and that four or five minutes at full load seldom proves injurous unless it comes too often in one run. We will have to admit the "flivver" has about the simplest of power plants, but to make it simple, many other good points had to be sacrificed, such as we never would tolerate in a Diesel engine.

As for comparing a "flivver" operator with a Diesel operator, there is no comparison. One is a pedal pusher and the other is one who knows what takes place when the pedal is pushed; in other words, one does his work with his feet and the other does his work with his head, and of course the pedal pusher does considerable work on a cold morning with his good right arm.

The man who says a skilled mechanic is unnecessary for operating a Diesel is either kidding himself or has lots to learn about a Diesel. An Apache Indian can run a "flivver," but would you hire one to run a Diesel? The Diesel and several semi-Diesel engines are a success; that we know. In most cases where they fail it is a failure of the engineer and not the engine. Let us accept this engine as it is and not as a simple apparatus that anybody can operate. If we do this, we will learn a lot about them and make them successful. But don't overload them.

Winkelman, Ariz. GEORGE J. TROSPER.

Replacing a Boiler-Feed Valve

I have had considerable experience with low-pressure heating boilers, and my opinion is that it would be a much quicker job to draw the fire, blow off the boiler and attach a new cock, than it would be to do the vacuum trick, as described by Mr. Cooper on page 826 of the May 27 issue.

I recollect a case under somewhat similar conditions, but the operator did not attempt any vacuum stunt. He used his jack-knife to trim out a wooden plug, bored a hole through it and used this plug for several hours until he was ready to put in another cock. The water caused the plug to swell somewhat but not enough to prevent its being turned in the body of the cock to supply water to the boiler.

Kingston, Ont., Canada. JAMES E. NOBLE.

Better Cylinder-Oil Testing Methods

On page 327 of the Mar. 4 issue of *Power*, I made a statement as follows: "The proper place to test a cylinder oil is in the cylinder of the engine in which it is to be used." I did not give my reasons for holding this belief, but for the edification of Mr. Weaver, who, on page 740 of the May 13 issue, draws the inference that I would feel inclined to try any old oil on my best engines, although a thousand employees were dependent on that engine for power, I will endeavor to state them briefly and simply.

Any test of power-plant apparatus is always made on the apparatus itself under as nearly actual operating conditions as it is possible to attain. I refer to efficiency tests particularly, and a lubrication test, as I conceive it, would be a test of the efficiency of the lubricant used on a machine when it is under actual operating conditions.

A present-day definition of lubrication efficiency would probably be a maximum degree of perfection of lubrication at a minimum cost. There is no one oil that will satisfactorily lubricate all cylinders, because all cylinders are not alike, nor are they operated under identical conditions. We have many variables, among them weight of the piston, area swept over by the piston, steam pressure and temperature and work done by the piston. I would certainly hesitate to use an oil on a 100-hp. engine, under 180 lb. steam, solely because it had proved satisfactory on a 4 x 6-in. engine under 60-lb. steam, nor would I be so foolish as to experiment with "any old oil on an engine upon which one thousand employees were dependent for power."

An engineer, in selecting a cylinder oil, uses judgment, based largely upon his experiences, under as nearly similar conditions as he has had, or upon the recommendation of the builders of the engine, who, in turn, arrive at their conclusions by practically the same method as the engineer, the main difference being a larger fund of experience from which to draw. Engineers are well aware that the valves of an engine will begin to show signs of distress, generally a groan, upon lack of lubrication and, in order to forestall this condition, make sure that enough oil is being fed without being quite so sure that too much is not being fed, which, it should be remembered, has a decided influence on the efficiency.

I have never seen an instrument or a device that would indicate to the engineer a deficiency of oil in the cylinder, nor have I seen anything of this kind advertised. I know of but two methods of detecting lack of lubrication. One is the sign of distress, so easily recognized by most engineers; the other is an examination of the interior of the cylinder. In either case it to too late, as a certain amount of damage (however slight it may be) has already been done. What is wanted is some device that will tell when not enough oil is being fed to the cylinder at the time that the deficiency exists and not a few hours later.

I suggested using a two-pen recording thermometer, one pen attached to the cylinder head and one to the center of the cylinder wall, assuming that there would be a slight difference of temperature between the two points, also a variation of temperature, according to the steam pressure carried. It seems reasonable to me to assume that the head would be at a slightly higher temperature than that at the center of the cylinder wall. Should there be a difference in temperature and a variation of the steam pressure, then the variation of the two lines should follow each other closely. Should there be no variation of the steam pressure, then a variation of the other line, in an upward direction, would indicate a rise in temperature, due to some other cause, which I am assuming to be friction.

If, as Mr. Weaver suggests, the heat of friction is carried away as fast as generated, then, certainly, my idea will not work. If not, I can see no reason why it should not work. Mr. Weaver should read my letter again. I did not make any suggestion to cut the oil down until a rise in temperature was perceptible. I assure him that I attempt no such foolish stunts. With no attempt at irrelevance, I would like to ask Mr. Weaver where he tests his cylinder oils.

New York City. WILBERT WALTON CRANFORD.

The Art of Synchronizing

I have read the editorial, "The Art of Synchronizing" in the Apr. 29 issue, and find it very significant to the engineer who has alternating-current machinery to deal with.

When I was learning to be an operator, I was instructed to close the switch on the incoming unit, with the synchronoscope turning very slowly in the fast direction, when the pointer was on the mark. To do this the operator must take into consideration that the oil-switch mechanism takes a fraction of a second to act, and he must close the pilot switch before the indicator reaches the mark by a few degrees. If the operator closes the pilot switch on either motions of the synchronoscope, he is sure of making some poor throws. Our best operators always close the switch on the incoming machine with the needle turning in the fast direction.

I know of a belt-driven station that was furnishing two-phase power, in which there was only one operator that was able to synchronize without making the belts squeak so that they could be heard two blocks away. One Sunday the chief engineer decided to try to remedy the difficulty. The plant had been in operation for several months, and lamps were used for synchronizing. The chief changed the wires of the lamps to the opposite phase on one of the machines, then on synchronizing everything was found to be correct, the trouble having been due to the synchronizing lamps being connected to opposite phases on the two machines.

I always have synchronized on the bright light instead of the dark, but either method is correct if the objective is obtained. Today a station that does not employ a synchronizing instrument for paralleling alternating-current generators is lacking in up-to-date methods. It is also very desirable that the voltage of the two machines be the same, although some operators are not careful in this respect. We operate both reciprocating-engine- and turbine-driven units and invariably use the throttle valve during synchronizing, although we may equalize the load while in operation by the governor motor.

Knowing what causes the trouble after it is all over is worth while, but knowing how to avoid it is worth a whole lot more. I heartily agree with Mr. Gillooly's statement, in the same issue containing the editorial, that an operator must read more from the instrument than is printed on the dial. P. W. PETERS.

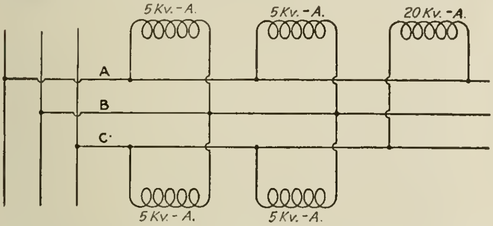
New York, N. Y.

Inquiries of General Interest

Use of Live-Steam Feed-Water Heater—What are the advantages of using a live-steam feed-water heater? F. R.

Live-steam feed-water heaters are of advantage when the feed water can be purified by heating it to a high temperature and also in preventing stresses in a boiler due to use of cold feed water. But there is no gain in economy from heating the feed water with live steam, as the heat added to the feed water is taken from the boiler and there is a loss by radiation of heat from the heater and its connections.

Balanced Load on Three-Phase System—Will a load distributed as in the figure, give a balanced condition in the three-phase distribution system? D. M. S.



The loading arrangement given in the diagram does not balance the three phases. There is 10 kv.-a. more load connected between *A* and *C* than there is between *A* and *B* or *B* and *C*. The total load on the system is 40 kv.-a. Then to divide this so as to put an equal load on each phase, ⅓ of 40, or 13⅓ kv.-a. will have to be connected between each pair of conductors. If the 20-kv.-a. load could be reduced to 10 kv.-a., this would balance the system against the 10 kv.-a. loads on each of the other two phases.

Muffler for Safety Valve—What means can be employed for silencing or deadening the noise of steam escaping from a high-pressure safety valve? J. H. S.

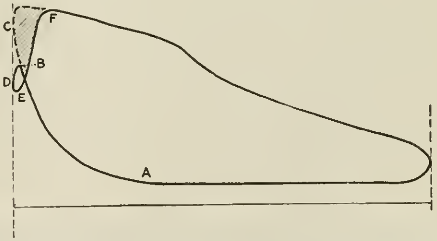
The sharp noise arising from the blowing off of a safety valve can be quieted by discharging the steam through a muffler in which the steam passes through a number of compartments with staggered openings for breaking up the regularity of vibration and gradually reducing the velocity of the escaping steam. Pop valves with combined mufflers are made with means for adjusting the relief pressure and the amount of blowdown. When a separate muffler is used, the relieving and blowdown pressures of the safety valve must be adapted to the back pressure incident to employment of the muffler.

Boiler Pressure Required for Pumping—What boiler pressure would be required to operate a direct-acting steam pump having an 8-in. diameter steam cylinder and a 6-in. diameter water cylinder, for pumping water to a height of 100 ft. with the suction water supplied at a pressure of 10 lb. per sq. in.? A. H.

The mechanical efficiency of a pump of the stated size, when in good working order, would be about 65 per cent. The pressure pumped against would be 100 × 0.433 = 43.3 lb. per sq. in. due to the head, plus the pressure required to overcome friction of the water in the discharge pipe, the latter depending on the rate of pumping and the diameter, length and fittings of the discharge pipe. Under ordinary conditions the loss of pressure from pipe friction would be no greater than 10 lb. per sq.in., and if assumed to be equal to the suction pressure, the net resistance to movement of the water piston would be (6 × 6 × 0.7854) × 43.3 = 1224 lb. With 65 per cent. mechanical efficiency of the pump, the resistance to be overcome by the steam piston would be 1224 ÷ 0.65 = 1883 lb., and for overcoming that resistance, the effective pressure required to be exerted on a direct-acting 8-in. diameter steam piston would be 1883 ÷ (8 × 8 × 0.7854) = 37.46 lb. per sq.in. The required boiler pressure will need to be equal to the effective pressure, plus the back pressure and the reduction of the boiler pressure by throttling in the steam pipe and steam passages of the pump. Allowing a back pressure of 4 lb. and reduction by throttling of 10 lb. per sq.in. would require a boiler pressure of 37.46 + 4 + 10 = 51.46, or about 52 lb. per square inch.

Engine Piston Over-riding Indicator Hole—If the piston of an engine travels over the hole in the cylinder for the indicator piping, how does it affect the diagram? W. L. R.

When the piston over-rides the hole in the end of the cylinder for the indicator connection, communication is temporarily cut off between the interior of the engine cylinder and the indicator cylinder, and if there were no leakage past either the indicator piston or the engine piston, the pressure of steam would remain constant and a short straight line would be traced on the diagram from the point in the return stroke at which the engine piston covered the opening to the end of the stroke, and the line would be retraced until the piston uncovered the hole. But there is always free leakage past the indicator piston and generally past the engine piston. Hence, there usually is a small drop of pressure indicated until the engine piston has again uncovered the hole, when the indicator pencil immediately rises to the point correctly corresponding with the pressure in the engine cylinder, the drop and rise forming a loop at the end of the diagram.



A diagram with such a loop is shown by the full lines of the illustration. The indication of increase in compression of the exhaust from *A* toward the end of the stroke is arrested at *B* by the engine piston covering the indicator connection and falls to *D* at the end of the exhaust stroke, whereas the engine cylinder pressure continues to rise and should be indicated by continuing the compression line from *B* to *C*. The indicator pencil continues to fall from *D* to *E* in the beginning of the admission stroke and at *E* the hole is again uncovered and the pencil rises to *F* in response to pressure within the cylinder, but without embracing the shaded area *B C F*, which should have been included in the diagram.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Universal Craftsmen's Convention

THE seventeenth annual convention of the Universal Craftsmen Council of Engineers was held in Newark, N. J., during the week beginning Monday, Aug. 4, with headquarters at the Robert Treat Hotel.

The several sessions of the delegates were held in the McCarter Library, situated on the main floor of the hotel, and the grand ballroom adjoining was neatly decorated and conveniently arranged for the use of the exhibitors in the display of engine-room supplies and power-plant equipment. Fifty-six firms occupied booths, and there were 75 contributors, several of whom were denied display space owing to the lack of room. The display was generously patronized throughout the week.

There were present between ninety and one hundred delegates, representing nearly two hundred votes, and many prominent out-of-town members who came as visitors. The important business of the convention was carried on with harmony and dispatch, and many resolutions tending to the uplift and enlarging of the organization were discussed and passed upon. The members were gratified with the reading of the treasurer's report, which places the association on a solid financial basis. There is to be an earnest educational drive throughout the several councils the coming fall and winter, and arrangements will be made for the engagement of professors of engineering for the purpose of instruction on technical subjects and for the delivering of suitable lectures. It is the opinion of some of the earnest members that there has been in the recent past a slowing down of the educational features of the organization, and that never before in the history of engineering was there a greater need for study and advancement, more especially in the operating line.

The delegates and supplymen and ladies were liberal in their praise of the local committee. There was not a detail for the comfort of the visitors that was overlooked. The committee comprised William G. Warfield, chairman; Ellwood Homsher, vice chairman; Joseph Paton, secretary, and John MacMorran, treasurer.

The opening ceremonies of the convention took place on Tuesday morning. William G. Warfield occupied the chair and made a brief address of greeting to the delegates and visitors and introduced A. Archibald, director of finance of the City of Newark, who heartily welcomed the convention. Grand Worthy Chief Frank M. Townsend responded for the engineers. He congratulated the supplymen on the excellence of their display, and expressed the wish that the spare moments of the delegates would be spent in visiting the many booths and viewing the interesting exhibit, many items of which were new and instructive. William J. Brennan, commissioner of public works, told of the immense manufacturing interests of Newark and hoped that the visitors would find time to inspect some of its plants. Mayor Charles P. Gillen hoped that the company would excuse his tardiness and said that he had just stolen away from the temporary city markets where he had been busy for some days in the important business of selling bacon, eggs and other war foods to the people at reduced prices. He spoke of the rapid growth of Newark and said many other pleasant things to the audience, concluding by wishing them a pleasant and profitable stay, saying that the services of the officers of the entire city government were at the disposal of the convention. A telegram was read by Chairman Warfield from Thomas L. Raymond, commissioner of public works, expressing regrets for his absence and sending his best wishes. Mr. Warfield then formally opened the exhibition, which brought the ceremonies to a close.

On Tuesday evening a lecture was delivered by C. W. Obert, on the A. S. M. E. Boiler Code, which was largely attended and proved of special interest.

At the close of the Wednesday afternoon session the past grand worthy chiefs formed an association, to be composed of past chiefs only, for the purpose of boosting the organization in general. O. M. Pomeroy was elected president and Charles Siegrist secretary.

On Thursday afternoon there was a steamboat excursion to Coney Island, which included refreshments and a combination ticket to the features at Luna Park.

The memorial services were conducted by Chaplain P. H. Early on Friday afternoon to pay tribute to the memory of the 38 brothers of the local councils who have passed away at home and abroad during the past year.

On Friday evening a banquet was held at the Washington Restaurant at which short addresses were made by the Rev. A. B. Fitz-Gerald, Commissioner William J. Brennan and Past Worthy Chief Frank Townsend. An entertainment was given by the New York "Bunch," including W. C. Eagon, of the Dearborn Chemical Co.; Bob Jones, of the France Packing Co.; Billy Murray, of Jenkins Bros.; Monroe Silver, the National Male Quartette and Jack Armour, of *Power*. Frank Martin, of Jenkins Bros., had the entertainment in charge, and William G. Warfield was the toastmaster. Dancing concluded a good night's fun.

During the week the ladies were entertained with auto rides, theater parties and shopping trips.

The election of the grand officers resulted as follows: Frank Conroyd, worthy chief, Chicago, Ill.; Andrew Benner, assistant worthy chief, Cleveland, Ohio; Frank M. Townsend, past worthy chief, Grand Rapids, Mich.; Thomas H. Jones, secretary, Washington, D. C.; John L. O'Brien, treasurer, Chicago, Ill.; William G. Warfield, warden, Newark, N. J.; Henry W. Burton, guard, Cleveland, Ohio; P. H. Early, chaplain, Milwaukee, Wis.; trustees, James M. Patton, Buffalo, N. Y.; George G. Brown, Pittsburgh, Penn.; W. W. Law, Trenton, N. J.

Springfield, Mass., was selected as the place for the next convention, which will be held in August, 1920.

DELEGATES, SUPPLYMEN AND VISITORS AT THE SEVENTEENTH ANNUAL CONVENTION OF THE

Physical Properties of Brines*

By E. F. MUELLER†

A CONSIDERABLE body of data is available relating to those physical properties of salt solutions which are of interest in refrigerating engineering, but it appears, because these data have not been assembled in a readily available form, that they have not been utilized as much as they might have been. An attempt will, therefore, be made to outline the manner in which the data may be tabulated.

The *specific gravity* of a brine is the ratio of the mass of unit volume of the brine at 60 deg. F. to the mass of unit volume of water at 39 deg. F.

The *concentration* of a brine is the number of pounds of (anhydrous) salt contained in one hundred pounds of brine.

The *specific heat* at any temperature is the number of British thermal units per degree required to raise the temperature of one pound (mass) of brine.

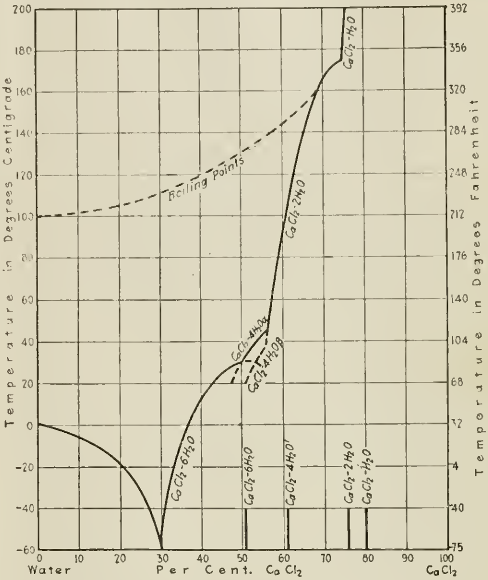
The *heat content* of a brine at any temperature is the number of B.t.u. which must be *absorbed* by one pound (mass) of the brine to change its temperature from 32 deg. F. to the temperature in question. The heat content will therefore be represented by negative numbers for temperatures below 32 deg. F.

The *B.t.u.* is here defined as the quantity of heat per degree required to raise the temperature of one pound (mass) of water at 60 deg. F.

The *freezing point* of a brine is the temperature at which crystals of ice first begin to separate out from the solution.

Solubility data for calcium chloride — The phenomena which occur on cooling a brine below its freezing point are perhaps of sufficient interest to warrant a digression from the main topic. In Fig. 1, which is taken from the Landolt-Bornstein-Roth Physical Chemical Tables, are shown the solubility data for calcium chloride in water. The ordinates represent temperatures and the abscissas the per cent. of salt in the solution. Thus any point at the left of the figure represents pure water (or ice) and any point at the right represents pure calcium chloride. The solid and broken curves represent conditions under which solutions and solids can exist in equilibrium, and the region above the curves represents conditions under which the solutions can exist. The upper dotted curve represents boiling points and, at atmospheric pressure, solutions cannot exist above this line; that is, solutions can exist only under the conditions of temperature and concentration defined by the region between the curves and the dotted line.

To illustrate, start with a 10 per cent. solution of calcium chloride at a temperature of, say, 20 deg. C. and cool it. The composition of course remains constant and a vertical line (falling temperature) is traced until the ice line is reached at a temperature of about —6 deg. At this point crystals of practically pure ice separate out (freezing point), consequently the concentration of the remaining solution increases in such manner that the ice line is traced with continuously decreasing temperature and continued separation of pure ice. When the solution has reached a concentration of about 29.9 per cent. the temperature will be —55 deg., the eutectic temperature. At this point another solid, the hexahydrate $CaCl_2 . 6H_2O$, appears and the temperature of the remaining liquid cannot be lowered, since any further abstraction of heat merely results in separating out a mixture of ice and hexahydrate at constant temperature (—55 deg.), this mixture having the same composition as the liquid (eutectic composition). At the eutectic temperature the two solids and the solution (29.9 per cent.) can exist in equilibrium, and as long as the three are present the temperature remains fixed.



SOLUBILITY OF CALCIUM CHLORIDE IN WATER

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS AT NEWARK, NEW JERSEY, AUGUST 8 TO 12

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*Abstract of a paper before the Spring Meeting, American Society of Refrigerating Engineers, Cincinnati, O.

†Associate Physicist, National Bureau of Standards.

If, instead of starting with a 10 per cent. solution, a 20 per cent. solution had been taken, the ice line would have been reached at a temperature of about —18 deg., after which the ice line would have been traced as before. On heating, the phenomena described would occur in reverse order.

If, instead of a 10 or 20 per cent. solution, a 40 per cent. solution had been taken, the phenomena would have been different. At about +12 deg. the hexahydrate line is reached and at this point the hexahydrate, which, as indicated in the lower part of the figure, consists of about 51 per cent. of salt, separates (freezes) out or, rather, crystallizes, the concentration of the solution decreases and the hexahydrate line is traced until the eutectic point at —55 deg. is again reached, at which point the mixture of ice and hexahydrate separates out as before. By starting with larger concentrations other parts of the curves may be traced. However, it can be seen from the figure that solutions more concentrated than about 69 per cent. cannot exist at atmospheric pressure, because the water would boil off. Starting, however, with a 60 per cent. solution at a temperature of 130 deg., on cooling the solution the dihydrate line is reached at a temperature of about 87 deg., the dihydrate begins to separate out and the dihydrate line is traced until it intersects the tetrahydrate line at about 45 deg. At this point, which is a transition point, the two hydrates and the solution (57 per cent.) can exist in equilibrium, and as long as the three are present the temperature remains fixed. If heat is abstracted from the mixture, more of the tetrahydrate crystallizes out and some of the dihydrate takes up the surplus water and is transformed into the tetrahydrate. This transition point is, therefore, markedly different from the eutectic, since at the eutectic the one solid form does not change into the other.

It will be noted that the tetrahydrate contains 61 per cent. of $CaCl_2$, consequently, if the solution had contained originally more than 61 per cent. of $CaCl_2$, the transition to the tetrahydrate could not have been completed. Having started with a 60 per cent. solution, however, the transition may be supposed to be completed, after which the tetrahydrate line would be traced down to the next transition point.

The above represents only a part of what can be read from such a diagram as Fig. 1, and the actual phenomena are by no means as simple as indicated in this rapid description. For example, the broken lines represent unstable equilibria of somewhat the same character as the well-known subcooling of water below its freezing point. It may also be seen that the so-called fused calcium chloride, containing 75 per cent. of calcium chloride, corresponds in composition to the dihydrate, and that that latter can be obtained by evaporating a solution to dryness at atmospheric pressure and a temperature of about 166 deg.

TABLE I—HEAT CONTENT IN B.T.U. PER POUND (MASS) OF CALCIUM CHLORIDE BRINES OF SEVERAL SPECIFIC GRAVITIES

Temp. Deg. F.	Specific Gravity (60 to 39 Deg.)									
	0.999	1.05	1.10	1.15	1.18	1.20	1.22	1.24	1.26	1.28
—20	....	....	....	....	....	....	....	—34.82	—34.00	—33.41
—19	....	....	....	....	....	....	....	—34.16	—33.42	—32.78
—18	....	....	....	....	....	....	—34.28	—33.50	—33.77	—32.14
—17	....	....	....	....	....	....	—33.61	—32.84	—32.13	—31.51
—16	....	....	....	....	....	....	—32.93	—32.18	—31.24	—30.87
—15	....	....	....	....	....	....	—32.25	—31.52	—30.88	—30.24
—14	....	....	....	....	....	....	—31.58	—30.86	—30.18	—29.60
—13	....	....	....	....	....	....	—28.96	—30.90	—30.19	—28.96
—12	....	....	....	....	....	....	—30.22	—29.53	—28.88	—28.33
—11	....	....	....	....	....	....	—29.54	—28.86	—28.28	—27.60
—10	....	....	....	....	....	....	—28.86	—28.20	—27.50	—27.05
— 9	....	....	....	....	....	....	—28.18	—27.54	—26.94	—26.41
— 8	....	....	....	....	....	—28.21	—27.50	—26.87	—26.28	—25.78
— 7	....	....	....	....	....	—27.51	—26.82	—26.21	—25.63	—25.14
— 6	....	....	....	....	....	—26.82	—26.14	—25.54	—24.98	—24.50
— 5	....	....	....	....	....	—26.12	—25.46	—24.88	—24.33	—23.86
— 4	....	....	....	....	....	—25.42	—24.78	—24.24	—23.68	—23.22
— 3	....	....	....	....	....	—24.72	—24.01	—23.54	—23.03	—22.53
— 2	....	....	....	....	—24.66	—24.02	—23.42	—22.88	—22.38	—21.94
— 1	....	....	....	....	—23.94	—23.32	—22.74	—22.21	—21.72	—21.30
0	....	....	....	....	—23.22	—22.62	—22.05	—21.54	—21.07	—20.66
1	....	....	....	....	—22.50	—21.92	—21.37	—20.88	—20.42	—20.02
2	....	....	....	....	—21.78	—21.22	—20.69	—20.21	—19.76	—19.38
3	....	....	....	....	—21.06	—20.52	—20.00	—19.54	—19.11	—18.74
4	....	....	....	....	—20.34	—19.82	—19.32	—18.87	—18.46	—18.10
5	....	....	....	....	—19.62	—19.12	—18.63	—18.20	—17.80	—17.46
6	....	....	....	....	—18.90	—18.41	—17.95	—17.53	—17.15	—16.81
7	....	....	....	....	—18.18	—17.71	—17.26	—16.86	—16.49	—16.17
8	....	....	....	—18.21	—17.45	—17.01	—16.58	—16.19	—15.84	—15.53
9	....	....	....	—17.46	—16.73	—16.30	—15.89	—15.52	—15.18	—14.88
10	....	....	....	—16.70	—16.01	—15.60	—15.20	—14.85	—14.52	—14.24
11	....	....	....	—15.95	—15.28	—14.89	—14.52	—14.18	—13.87	—13.60
12	....	....	....	—15.19	—14.56	—14.19	—13.83	—13.51	—13.21	—12.95
13	....	....	....	—14.44	—13.84	—13.48	—13.14	—12.83	—12.55	—12.31
14	....	....	....	—13.68	—13.11	—12.78	—12.45	—12.16	—11.90	—11.66
15	....	....	....	—12.93	—12.39	—12.07	—11.76	—11.49	—11.24	—11.02
16	....	....	....	—12.17	—11.66	—11.35	—11.08	—10.82	—10.58	—10.37
17	....	....	....	—11.41	—10.94	—10.66	—10.38	—10.14	— 9.92	— 9.73
18	....	....	....	—10.65	—10.21	— 9.95	— 9.70	— 9.47	— 9.26	— 9.08
19	....	....	....	— 9.89	— 9.48	— 9.24	— 9.01	— 8.80	— 8.60	— 8.43
20	....	....	....	— 9.14	— 8.76	— 8.53	— 8.32	— 8.12	— 7.94	— 7.79
21	....	....	— 9.11	— 8.38	— 8.03	— 7.80	— 7.62	— 7.44	— 7.28	— 7.14
22	....	....	— 8.28	— 7.62	— 7.30	— 7.11	— 6.93	— 6.77	— 6.62	— 6.49
23	....	....	— 7.46	— 6.86	— 6.57	— 6.40	— 6.24	— 6.09	— 5.96	— 5.84
24	....	....	— 6.63	— 6.10	— 5.84	— 5.69	— 5.55	— 5.42	— 5.30	— 5.20
25	....	....	— 5.80	— 5.34	— 5.12	— 4.98	— 4.86	— 4.74	— 4.64	— 4.55
26	....	....	— 4.98	— 4.57	— 4.38	— 4.27	— 4.16	— 4.07	— 3.98	— 3.90
27	....	....	— 4.15	— 3.81	— 3.65	— 3.56	— 3.47	— 3.39	— 3.32	— 3.25
28	....	....	— 3.32	— 3.05	— 2.92	— 2.85	— 2.78	— 2.71	— 2.65	— 2.60
29	....	....	— 2.74	— 2.49	— 2.19	— 2.14	— 2.08	— 2.03	— 1.99	— 1.95
30	....	— 1.83	— 1.66	— 1.53	— 1.46	— 1.43	— 1.39	— 1.36	— 1.33	— 1.30
31	....	— .91	— .83	— .76	— .73	— .71	— .70	— .68	— .66	— .65
32	0.00	0	0	0	0	0	0	0	0	0
35	3.02	2.74	2.49	2.29	2.20	2.14	2.09	2.04	1.99	1.95
40	8.05	7.30	6.65	6.12	5.87	5.72	5.57	5.44	5.32	5.22
45	13.07	11.87	10.82	9.96	9.55	9.30	9.07	8.86	8.66	8.49
50	18.08	16.44	15.00	13.81	13.24	12.90	12.57	12.28	12.01	11.77
55	23.08	21.02	19.18	17.67	16.94	16.50	16.09	15.72	15.37	15.06
60	23.08	25.60	23.38	21.54	20.65	20.12	19.61	19.16	18.73	18.36
65	33.07	30.18	27.58	25.42	24.37	23.74	23.14	22.61	22.11	21.67
70	38.06	34.77	31.78	29.30	28.10	27.37	26.69	26.07	25.50	24.99

Andrew Carnegie

In the quiet of his Berkshire home, in the 84th year of his age, Andrew Carnegie passed away on Monday of last week. If it had not been for the steam engine, he might have passed away at Dumferline, Scotland, leaving a little weave shop instead of a colossal fortune.

He was a conspicuous example of the success which comes from apparent misfortune, of achievement inspired and induced by hard knocks. His father was a hand weaver in Dumferline, with four damask looms and a number of apprentices. The business was made unprofitable by the coming in of the factory system, and the family came to America in 1848, father and mother, Andy, 13, and Tom, 6 years old, and settled down in Barefoot Square, Slabtown, Penn.—about as discouraging a beginning as the fates could have laid out.

ANDREW CARNEGIE

Although his career was that of the ironmaster and financier, he was tied into the field in which *Power* is interested in many ways. Almost the first employment which he found in the country of his adoption was that of fireman in the factory where his father worked at his trade and where the boy served a short term as bobbin boy at $1.20 a week. In later life he wrote a biography of James Watt. In 1851, at the age of 16, he became a messenger boy for the Ohio Telegraph Co., learned to use the instruments and became an operator for the Pennsylvania Railroad. A wreck occurring in the absence of Thomas A. Scott, the division superintendent, young Carnegie took it upon himself to send out telegrams with the superintendent's signature, holding trains and straightening out the tangle so cleverly that Mr. Scott made him his secretary and assisted him in making his first investments. When his patron was made Secretary of War, Carnegie was made superintendent of military railways and government telegraph lines in the East. Returning with his chief to Pittsburgh in 1862, fortunate investments, principally in oil lands, brought him returns which made him a real capitalist.

He organized the Keystone Bridge Works for building bridges of iron instead of wood; and later the Union Iron Mills. While on a visit to England in 1868, he learned of the new bessemer steel process and returned to America bent upon its exploitation. This led to his becoming the principal owner of the plant at Braddock, Penn., and he soon absorbed the Homestead establishment across the Monongahela. This commenced the formation of the Carnegie interests, which subsequently netted him $250,000,000. Out of the wealth thus acquired liberal donations have been made for various purposes, those most intimately interesting our readers being the Carnegie Institute at Pittsburgh, the Carnegie Institution at Washington, a day school of mechanical arts at Cooper Union, the Engineers' Club of New York and the United Engineering Societies Building, which houses the great national engineering societies. Mr. Carnegie donated a million and a half for the two latter buildings on condition that the club and societies purchase the land. This was done and the buildings were completed in 1907. Of these he took a special interest in the American Society of Mechanical Engineers, in the Year Book of which his name appears as an honorary member with the simple designation, "philanthropist."

American Electrochemical Society's Fall Meeting

The American Electrochemical Society will hold its fall meeting in Chicago, Ill., Sept. 23-26, with headquarters at the Congress Hotel. A tentative program has been arranged and calls for four joint sessions with the American Institute of Mining and Metallurgical Engineers, which will hold its convention at the same time and place. The program as now arranged is as follows:

Tuesday, Sept. 23—Excursion by boat with American Institute of Mining and Metallurgical Engineers to Gary, Ind., and trip through the United States Steel Corporation's plant. Joint technical session, on the boat, returning from Gary, subject: Electrometallurgy of Iron and Steel. Joint technical session, at Congress Hotel at 8:30 p.m.

Wednesday, Sept. 24—Morning, session for reading and discussion of papers; afternoon, joint, Ferrous Metals; evening, inspection of the electric furnace exhibits at the Chemical Exposition.

Thursday, Sept. 25—Morning and afternoon, Symposium of Catalysis; evening, smoker and entertainment.

Friday, Sept. 26—Morning and afternoon, joint session; subject, Symposium on Pyrometry.

The secretary of the society is Prof. Joseph W. Richards, Lehigh University, Bethlehem, Penn.

A. I. E. E. and N. E. L. A. Committee on Power Factor in Polyphase Circuits

A recent issue of the N. E. L. A. *Bulletin* announces the formation of a special joint committee on the determination of power factor in polyphase circuits, by the American Institute of Electrical Engineers and the National Electric Light Association. The present personnel of the committee is as follows: R. J. McClelland, chairman; Farley Osgood, vice chairman; S. G. Rhodes, secretary; Dr. P. G. Agnew, Frank Conrad, F. P. Cox, F. C. Holtz, Dr. A. E. Kennelly, E. W. Lloyd, G. A. Sawin, R. F. Schuchardt. It is the intention to report to the A. I. E. E. and the N. E. L. A. at the annual conventions next summer. The committee's plans are as follows:

1. To establish the purpose to be fulfilled by the use of the function known as "Power Factor," in the commercial, engineering and scientific aspects of the electrical art.

2. To establish a definition of the function which will definitely and correctly express this purpose, and will be suitable for scientific, legal and commercial use. A definite recommendation for such a definition will be offered.

1. To study and offer suggestions as to methods of measurement of power factor and to point out the applicability and limits of error of various methods of measurement.

4. Possibly to study and offer suggestions as to various methods of providing for power factor in contracts and rates.

The committee invites and hopes to receive suggestions and expressions of opinion, as well as statements of experience as to commercial application of power factor measurements.

Boston Engineers and Firemen Receive Increased Wages

Municipal stationary and marine engineers, firemen and oilers at Boston, Mass., were granted increased wages by Mayor Peters at a conference on Aug. 6, upon the ground that the previous rates of pay were below those prevailing in commercial establishments in the Boston district. A strike was threatened which might have resulted in serious interruptions in service in the sewage-pumping plants, ferries and public buildings of the city. Mayor Peters cut short his vacation and hastened to Boston to discuss the situation with the representatives of the engineers and firemen involved, and the result was a general standardization of pay corresponding to outside scales. The following rates have been established:

	Per Week
Operating engineers at pumping stations	$37
Marine engineers on city ferries	42
Engineers in charge, public buildings, first-class plants	42
Engineers operating public buildings, first-class plants	37
Engineers in charge, second-class plants	37
Engineers operating second-class plants	33
Engineers in charge, third-class plants	33
Engineers operating third class plants	30

Firemen and oilers in all plants, $5 per day.

In announcing these rates, Mayor Peters stated that the demands of the engineers, firemen and oilers for increased wages were originally received by him in June and that since that time he has been undertaking an extensive investigation into every phase of the situation. The mayor said:

> It has become apparent to me that the work of this class of employees is just as arduous and exacting as that of similar employees of public-service corporations and individual firms in the city and in this respect lacks the advantages and privileges that go with many of the other classes of employment in the city service. As these men are working under conditions that are the same as in outside employment, they are entitled to the prevailing rate of wages established for that class of work.
>
> It should be borne in mind that most of the men affected by this change in the wage scale work the full six days a week and are thus denied the privilege of a Saturday half-holiday enjoyed by a large number of other employees, while the important character of the service rendered by them in hospitals, institutions, pumping stations and ferries was another factor in their favor. In short, their situation was an isolated one and distinctly different from that of other classes of city employees.
>
> Under the new wage scale engineers, firemen and oilers will be required to work the full six days of eight hours each, or 48 hours per week, and this arrangement was quite agreeable to the representatives of the union who called upon me. Because of the change in the wage scale of the engineers, etc., on the ferryboats, it will be necessary to readjust the salaries of the captains and quartermasters on these boats. Appropriate changes will be made when the other changes go into effect.

Michigan Section, N. E. L. A. Changes Dates for Conventions

At the Hotel Ottawa, Ottawa Beach, Mich., the Michigan Section of the National Electric Light Association will hold its convention Aug. 26 to 28. The date is one week later than that originally planned. The program as arranged includes six sessions, as follows:

Aug. 26, Morning Session—Address by President Thomas Chandler; address, "New Public Utilities Bill," by James V. Oxtoby; paper, "More Favorable Policy Toward Consumers," by John Swanson; paper, "The Central Station and the Contractor-Dealer," by R. A. Gordon.

Aug. 26, Afternoon Session—Paper, "Commercial Lighting," by J. F. Mayo; paper, "Practical Phases of Industrial Lighting," by H. H. Magdsick.

Aug. 26, Special Evening Session—Paper, "Safety," by Harry Burton; "The Queen of the Waves," two-reel educational film showing progress of electricity in navigation; illustrated talk by W. A. Durgin, on "Industrial Illumination."

Aug. 27, Morning Session—Paper, "Appliance Sales in the Detroit Edison Company's Suburban Districts," by A. H. Touscany; paper, "Electrical Merchandising," by H. H. Koelbel; paper, "Domestic Refrigeration," by E. J. Copeland; paper, "Electric Ranges, Their Sale and Operation," by R. F. Hotton.

Aug. 27, Dinner—Address, "Municipal Ownership," by F. G. R. Gordon, entertainment as arranged by the committee.

Aug. 28, Morning Session—Paper, "Insurance," by J. H. Lobban; paper, by J. A. Cavanaugh.

Correction of Error in 1918 Edition of National Electrical Code

In the 1915 edition of the National Electrical Code the second paragraph of Rule 23, section "a" reads as follows:

> Where the switch required by No. 24 "a" is inside the building, the cutout required by this section must be placed so as to protect it, unless the switch is of the knife-blade type and is inclosed in an approved box or cabinet, under which conditions the switch may be placed between the source of the supply and the cutout.

Through an error this section was omitted when the 1918 edition was printed. The Electrical Committee of the National Fire Protection Association has voted that this matter be given the widest publicity, that all interested parties may be advised that this section was omitted. The Electrical Committee would recommend that the Inspection Departments approve an installation in accordance with this paragraph.

New Publications

AIRPLANE DESIGN AND CONSTRUCTION. By Ottorino Pomilio, Consulting Aëronautical Engineer for the Pomilio Brothers Corporation. Published by the McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City; Hill Publishing Co., Ltd., 6-8 Bouverie St., E. C., London. Cloth, 6 x 9 in., 403 pages; numerous illustrations and diagrams.

The reputation of the Pomilio Brothers Corporation as airplane designers and constructors is so well established that a treatise by their consulting engineer should take rank as an authority on airplane construction. In this volume the subject is divided into four parts, the first three being included under the general heading, "Structure of the Airplane," and the remaining one under "Design of the Airplane." The text is so arranged that it can be adapted to either elementary or advanced college courses in airplane design. For the airplane engineer the fourth part, on design, should prove a valuable reference and time-saver, as it is replete with tables and diagrams. Unfortunately, the space devoted to the very important subject of testing is far too brief. It seems a pity that Mr. Pomilio could not have secured as a collaborator some one of our engineers who is used to technical writing, as in some places the literal translations of Italian technical descriptions make rather unusual and even ambiguous English.

Personals

O. P. Hood is Acting Director of the Bureau of Mines in the absence of Van H. Manning, who is visiting the various experiment and rescue stations of the Bureau.

C. R. Matheny, sales manager of the Republic Flow Meter Co., called upon us on his way to Pittsburgh, where he is to open an office for his company about October first.

Professor Anguste C. E. Rateau, of Paris, France, has been granted the gold medal of the British Society of Mining Engineers, an additional new distinction conferred on the professor.

J. L. Canby has been appointed district manager of sales at Chicago for the Chicago Pneumatic Tool Co., succeeding Nelson B. Gatch, who has been transferred to the New York office as district manager of sales.

Business Items

The Green Engineering Co., East Chicago, Ind., announces the appointment of the firm of Bull & Livensparger as its sales representatives in Chicago and northern Illinois territory. E. H. Bull has been connected with the company as an engineer for the last seven years and D. A. Livensparger has been a member of the sales force for nine years. Their offices will be at 14 E. Jackson Boulevard, Chicago.

Trade Catalogs

The Mesta Machine Co., Pittsburgh, Penn., has recently issued a 127-page general catalog, bound in cloth and richly printed and illustrated. It gives a brief illustrated description of the plant and product of the company. The plant, which covers twenty acres, and equipment are so arranged that all machinery is built complete within the plant from the raw materials. This company builds a more complete line of heavy machinery for iron and steel works than any other company in the United States. The catalog is printed in French as well as in English.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8 35

Bituminous

	Clearfields	Cambrias and Somersets
F. o. b. mines, net tons	$2.60@3.10	$3.00@3.60
F. o. b. Philadelphia, gross tons	4.79@5.35	5.20@5.80
F. o. b. New York, gross tons	5.10@5.70	5.50@6.20
Alongside Boston (water coal), gross tons	6.85@7.35	7.10@7.85

Georges Creek is quoted at $3.70 per net ton, f. o. b. mines.

Pocahontas and New River are being quoted at $6.25@6.50 per gross ton f.o.b. Norfolk and Newport News, Va., in response to export demand. There are practically no sales for coastwise shipment.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5.95	$7.80	Pea	$5.20	$6.95
Egg	6 25	8.10	Buckwheat	3.40	5.15
Stove	6.50	8.35	Rice	2.75	4.50
Chestnut	6.60	8.45	Barley	2.25	4.00

Bituminous

Current quotations on spot coal, net tons, at the mines average about as follows:

	Spot
South Fork (best)	$3.15@3.35
Cambria (best)	2.95@3.10
Cambria (ordinary)	2.75@2.95
Clearfield (best)	2.95@3.10
Clearfield (medium)	2.75@2.95
Clearfield (poor)	2.50@2.75
Reynoldsville	2.70@2.90
Quemahoning	3.10@3.25
Somerset (best)	2.95@3.10
Somerset (poor)	2.50@2.75
Western Maryland	2.50@2.75
Fairmont	2.10@2.35
Latrobe	2.60@2.65
Greensburg	2.50@2.60
Westmoreland ¾ in.	2.75@2.90
Westmoreland run-of-mine	2.50@2.60

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide	Anthracite	Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	6.25	8.10	Rice	2.75	3.65
Stove	6.50	8.35	Boiler	2.50	3.50
Nut	6.60	8.45	Barley	2.25	3.15
Pea	5.20	6.80			

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3.25
Mine-run	2.35@ 2.50	3.00
Screenings	1.40@ 1 60	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.45	$2.75	$2.40
Black Creek and Cahaba	3.45	3.75	3.05
Jagger - Pratt Corona	2.85	3.05	2.45
Blacksmith	....	5.25	.....

Domestic quoations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3.95@$4.60
Corona	3.50
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

	Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$2.85*@3.05	$2.55	$2.25@2.50
Mine run	2.10*@2.35	2.35	1.60@1.70
Screenings	1.50*@2.20	2.05	.90@1.00

* Indicates prices on independent coal.

Williamson-Franklin rate to St. Louis is $1.07½; other rates $0.92½.

New Construction

PROPOSED WORK

Mass., Williamstown—The J. S. Boyd Co. is having plans prepared by Edmund F. Saxton, Cons. Eng., Tremont Bldg., Boston, for water power development, here.

N. Y., Amsterdam—The Consolidated Creamery Co., Fultonville, will receive bids for replacing engine, boiler and transmission and milk handling equipment which was recently destroyed by fire, with a loss of $100,000.

N. Y., Buffalo—The Pierce-Arrow Motor Co., 1695 Elmwood Ave., plans to build a 2 story addition to its boiler house at 1695 Elmwood Ave. Estimated cost, $100,000.

N. Y., Central Islip—The State Hospital Commission, Capitol, Albany, received bids July 29 for installing at the State Hospital, here, stokers, etc., in new central heating and lighting plant, from Chute. Thorton & Bailey Corporation, 2 East 13th St., New York City, $81,600; W. B. Armstrong Co., 3 Fulton St., Albany, $82,341; John W. Danforth Co., 70 Ellicott Sq., Buffalo, $82,993.

N. Y., Copenhagen—C. W. Pratt, of Island Paper Co., Tannery Island, Carthage, has purchased the High Falls hydro-electric development, here, and plans to double present 1000 hp. installation by building reinforced concrete addition to plant and new 1000 hp. generating unit. Estimated cost, $25,000.

N. Y., Hobart—The Board of Education of the Union Free School, District No. 4, Stamford Twp., will receive bids until August 23 for the construction of a 2 story, 36 x 100 ft., school. A steam heating system will be installed in same. Total estimated cost, $300,000. Rasmussen & Wegland, 1133 Broadway, New York City, Arch.

N. Y., Malone—The State Armory Bd., Capitol, Albany, received bids July 17 for installing heating system in the proposed addition to the armory, here, from Ryan Plumbing & Heating Co., Inc., Smith St., Watertown, $5,417; Thomas Breen Co., 414 Lafayette St., Utica, $5496; Adams, Britz & Co., Inc., 1761 Park Ave., New York City, $5668.

N. Y., Ripley—The Ripley Milk Products Co., plans to construct a cheese and butter plant and pasteurizing station. Company will install engine, boiler, ammonia system and milk handling machinery. Total estimated cost, between $60,000 and $75,000. C. B. Newbury, Pres.

N. Y., Rochester—Lesser Paley, Chn. of the Building Committee for the Rochester Jewish Home for the Aged, plans to install a steam heating system, elevator, etc., in the Wagner Memorial College on Oregon St. Estimated cost, $40,000.

N. Y., Syracuse—The American Agricultural Chemical Co., 92 State St., Boston, Mass., has acquired a site on the Barge Canal and Hiawatha St. and will erect a 3 story, 180 x 340 ft. warehouse, including 2 railroad sidings, concrete unloading pier with overhead unloader and conveyor system and overhead trestle with electric hauling units. Total estimated cost, between $300,000 and $500,000.

N. Y., Thiels—F. A. Vanderlip, Pres. Bd. Mgrs., Letchworth Village, 7 Wall St., New York City, received bids for installing heating system in the eight 1 story, 34 x 150 ft., steel cottages, here, from John C. Williams, Inc., 233 Broadway, $163,741; Adams, Britz & Co., Inc., 1761 Park Ave., $167,000; Lord Construction Co., 105 West 40th St., $168,500; contractors all of New York City.

N. Y., Utica—The State Hospital Commission, Capitol, Albany, received bids for installing a heating system in the buildings for Chronic Patients, at the Utica State Hospital, from the Globe Automatic Sprinkler Co., Cahill Bldg., Syracuse, $88,600; John W. Danforth Co., 70 Ellicott Sq., Buffalo, $92,590; H. C. Peterson Co., Inc., 20 Oneida St., $93,925.

N. Y., Watertown—Kops Brothers have acquired the plant of J. B. Wise, Inc., on Water St., and plan to install new machinery and transmission equipment for their own use. Total estimated cost, between $30,000 and $35,000.

N. J., Newark—The Board of Freeholders of Essex County received lowest bid for installing a heating and piping system in the proposed new sanitarium from Gillis & Geoghegan, 537 West Broadway, New York City, at $59,500.

Penn., Philadelphia—J. Miller & Sons Co., 16th and Reed St. is receiving bids for the construction of a 3 and 5 story, 98 x 118 ft. factory. A steam heating system will be installed in same. F. E. Hahn, 1112 Chestnut St., Arch.

Penn., Pittsburgh—The Atlantic Refining Co., Chamber of Commerce Bldg., will construct a 1 story, 45 x 125 ft. boiler house on 57th and Butler St. Estimated cost, $25,000.

Penn., Pittsburgh—The Board of Education, Fulton Bldg., plans to construct a 3 story, 170 x 303 ft. high school in Sheridan District. A boiler room, steam heating and ventilating systems and high pressure boilers will be installed in same. Total estimated cost, $664,500. McClure & Spahr, Keystone Bldg., Arch.

Penn., Pittsburgh—The Board of Education, Fulton Bldg., is having plans prepared for the construction of a 3 story, 130 x 242 ft. school on Perryville Ave., to to be known as Perry Elementary School. Steam heating and ventilating systems and low pressure boilers will be installed in same. Total estimated cost, $612,000. R. Kiehnell & Elliott, 245 4th Ave., Arch.

Penn., Pittsburgh—The Board of Education, Fulton Bldg., is having plans prepared for the construction of a 3 story, 75 x 340 ft. school on Greenfield Ave., to be known as Greenfield Elementary School, to include a boiler room, low pressure boilers and steam heating and ventilating systems. Total estimated cost, $598,720. Kiehnell & Elliott, 245 4th Ave., Arch.

Penn., Pittsburgh—The Board of Education, Fulton Bldg., plans to build a 3 story, 70 x 320 ft. school, to be known as Beechwood-Beechwood Elementary School. Steam heating and ventilating systems and low pressure boilers will be installed in same. Total estimated cost, $553,040. Press C. Boiler, Magee Bldg., Arch.

Ohio, Ashtabula—The city will receive bids until September 10 for installing a 1000 K.W. generator and equipment in the electric-light plant. Estimated cost, $50,000. Morris-Knowles, Jones Law Bldg., Pittsburgh, Penn., Engr.

Ohio, Madison—The city has retained W. J. Sherman, Engr., 613 Nasby Bldg., Toledo, to prepare plans for new water supply system and electric-light and power plants.

Ohio, Newark—Warren S. Weiant & Son have had plans prepared for a 3 story, 49 x 66 ft., power plant. Boiler-room equipment and coal bunkers will be installed in same. Bodenstein & Surmann, 405 Second National Bank Bldg., Cincinnati, Engr.

Ohio, Oxford—The village has sold its electric-light plant and will use proceeds, amounting to $35,000, to improve the waterworks, including new electric pumping equipment, new service mains, etc.

Ohio, Ravenna—The New Cascade Tire & Rubber Co. plans to build a 2 story tire plant here. A steam heating system will be installed in same. Total estimated cost, $1,000,000. Osborn Engineering Co., 2848 Prospect Ave., Cleveland, Engr.

Mich., Detroit—The Department of Purchases & Supplies, Municipal Courts Bldg., will soon award the contract for furnishing 4 gasoline driven double diaphram trench pumps with 3 in. suction and discharge hose, mounted on wheels; also 4 trench backfillers, equipped with one-man scraper, gasoline engines and caterpillar traction. Address J. A. Martin.

Mich., Detroit—The Masonic Athletic Association, c/o G. W. Graves, Arch., 43 John R. St., is having plans prepared for a 3 story, clubhouse on the shore of Lake St. Clair. A steam heating system will be installed in same. Total estimated cost, $100,000.

Mich., Port Huron—The Holmes Foundry Co. plans to install a fire protection system, including a 1000 gal. per minute centrifugal pump, 100 lb. pressure, with 100 H.P. 200 volt direct current motor, automatic starter, compensator and all necessary wiring, about one mile of extra heavy 10 in. cast iron pipe and 800 ft. of 8 in. pipe, all laid on concrete base; also pump house, intake, well and cribbing at foot of Connor St. on the St. Clair River. Estimated cost, $31,000.

Minn., Foley—The city is having plans prepared for the construction of waterworks and sewerage systems, including 60,000 gal., steel tank pump and 1000 gal per minute motor. Estimated cost, $40,000. Chute & Bradley, St. Cloud, Engrs.

Neb., Broken Bow—The Custer Electric Co. is in the market for a 125 or 150 h.p. Corliss engine, direct or belted.

Mo., Duenweg—The M. & T. Mining Co. plans to move its mill from Granby District and erect same here, and is in the market for boiler, steam engine, compressor and rolls. R. McGee, Gen. Mgr.

Mo., Excelsior Springs—The Masonic Building & Realty Co. plans to build a 3 story temple. A steam heating system will be installed in same. Total estimated cost, $100,000. Owen & Payson, Kansas City, Mo., Arch.

Mo., St. Joseph—Buchannan County is having plans prepared for the construction of a 2 story infirmary. A steam heating system will be installed in same. Total cost, $235,000. R. Meier, W. Boschers and R. Arnold, Arch.

Okla., Guthrie—The Scottish Rite Consistory plans to construct a consistory building. Total estimated cost, $500,000. Hawk & Pain, Oklahoma, Arch.

Wash., Everett—The city is having preliminary plans prepared for developing 5000 to 6000 hp. electric power water plant; work involves enlargement of present dam, constructing new dam and building tunnel through rock walls. Water is to be taken from Sultan River. Estimated cost, $10,000.

Cal., Pasedena—S. B. Morris, Ch. Engr., City Water Dept., has recommended that city construct distributing system in San Rafael Heights, to cost $100,000, a reservoir at about $17,000, also the installation of a booster pump.

Ont., Brantford—The Cockshutt Plow Co. plans to build a 1 story, 50 x 60 ft. and a 4 story, 100 x 145 ft. addition to its plow factory. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ont., London — The Greene Swift Co., will soon award the contract for the construction of a 4 story, 40 x 100 ft. factory addition on Talbot St. An engine and boiler will be installed in same. Total estimated cost, $50,000. W. S. Murray, Dominion Savings Bldg., Arch.

Ont., Windsor—A. H. McPhail, Arch., Board of Trade Bldg., is preparing plans for the construction of a 6 story, 30 x 120 ft. mercantile building on Ouellette Ave., for C. H. Smith Co., Pitt St. A steam heating system will be installed in same. Total estimated cost, $100,000.

B. C., Merritt—Nicola Pine Mills, Ltd., plans to build new saw mills. Steam boilers, engines and saw mill equipment will be installed in same. Estimated cost, $250,000. Work to start as soon as possible.

CONTRACTS AWARDED

Conn., Bristol—The New Departure Manufacturing Corporation, 269 North Main St., has awarded the contract for the construction of a 6 story, 75 x 157 ft. brick and concrete hotel on North Main St., to Ellison Construction Co., 98 Wellington Ave., Hartford. A steam heating system will be installed in same. Total estimated cost, $200,000.

Conn., Hartford—The Hartford Electric Light Co., 266 Pearl St., has awarded the contract for placing high tension suspension line across the Connecticut River, below Dutch Point, to Fred T. Ley, 495 Main St., Springfield, Mass. Contractor will sublet construction of two 160 ft. steel towers. Total estimated cost, $50,000.

R. I., Woonsocket—The Barnai Worsted Co., South Main St., has awarded the contract for the construction of a 1 story, 35 x 130 ft. dye house and a 35 x 40 ft. boiler house, to J. H. Grozier Co., 756 Main St., Hartford, Conn. Total estimated cost, $25,000.

N. Y., Astoria—Glynne & Ward, Alhambra Theatre, Halsey St. and Knickerbocker Ave., Brooklyn, have awarded the contract for the construction of a 2 story theatre here, to H. Shapiro, 52 Vanderbilt Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $400,000. Noted May 13.

N. Y., New York—Baker, Carver & Morrell, 39 Water St., have awarded the contract for building a 9 story, 28 x 83 ft. office at 37 Water St., to C. L. Frazer, 103 Park Ave. A steam heating system will be installed in same. Noted Aug. 5.

N. Y., New York—The Broadway-John St. Corporation, 206 Broadway, has awarded the contract for the construction of a 7 story, 53 x 83 ft. office building at 19-23 Bridge St. through to 2-4 Stone St., to the Fleischman Construction Co., 531 7th Ave. A steam heating system will be installed in same. Total estimated cost, $300,000.

N. Y., New York—Post & Flagg, 28 Wall St., have awarded the contract for the construction of a 6 story, 50 x 100 ft. office building at 49-51 Broad St., to Cauldwell-Wingate, 281 4th Ave. A steam heating system will be installed in same.

N. Y., New York—Street & Smith, 161 West 15th St., have awarded the contract for building a 7 story, 50 x 100 ft. publishing house, to Fountain & Choate, 110 East 23d St. A steam heating system will be installed in same. Total estimated cost, $125,000. Noted July 15.

N. Y., Schenectady—The Gloversville Knitting Mills Co., Gloversville, has awarded the contract for remodelling the Congress St. Theatre, here, for its own use, to Shear & Gordon. A steam heating system and transmission equipment will be installed in same. Total estimated cost, between $25,000 and $35,000.

N. Y., Utica.—The Trustees of the Masonic Home have awarded the contract for the construction of a 4 story, 41 x 54 x 217 ft. memorial hospital on Bleecker St. and Prospect Park, to John F. Hughes Construction Co., 211 Post St. A steam heating system will be installed in same. Total estimated cost, $300,000.

N. J., Camden—The Standard Oil Co., 26 Broadway, New York City, has awarded the contract for the construction of a 4 story, storage plant, to the White Engineering Co., 95 Madison Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $600,000.

N. J., Passaic—The General Silk Importing Co., c/o Lockwood, Greene & Co., Archts., 101 Park Ave., New York City, has awarded the contract for the construction of a reinforced concrete factory, to J. W. Ferguson, Paterson. A steam heating system will be installed in same. Total estimated cost, $200,000.

N. J., Red Bank—The Standard Oil Co., 26 Broadway, New York City, has awarded the contract for the construction of a 2 story garage, to the White Engineering Co., 95 Madison Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $100,000.

N. J., Trenton—Standard Oil Co., 26 Broadway, New York City, has awarded contract for constructing a 3 story storage plant, to the White Engineering Co., 95 Madison Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $300,000.

N. C., High Point—The Southern Furniture Exposition Building, Inc., has awarded the contract for a 10 story, 100 x 208 ft. building on Main St., to W. P. Rose, Goldsboro, N. C. A steam heating system will be installed in same. Total estimated cost, $450,000.

Ohio, Cleveland—Aetna Rubber Co., 815 East 79th St., has awarded the contract for building a 1 story, 29 x 37 ft. boiler room at 815 East 79th St., to George P. Ford Co., East 40th St. Estimated cost, $6000.

Ohio, Cleveland — The Bamberger-Reinthal Co., 2621 East 9th St., has awarded the contract for building a 3 story, 70 x 180 ft. factory on Grand Ave., to Bolton & Pratt, 801 Columbia Bldg. A steam heating system will be installed in same. Total estimated cost, $100,000.

Wis., Sheboygan—The Haack Motor Co. has awarded the contract for the construction of a 2 story, 63 x 120 ft. garage on 12th St. and Indiana Ave., to C. Haack, Sheboygan. A steam heating system will be installed in same. Total estimated cost, $60,000.

Kan., Wichita—The Board of Education has awarded the contract for installing a steam heating system in the proposed new Emerson School, to the Salina Plumbing Co., Salina. Estimated cost, $20,380.

Mo., St. Louis—M. C. Giles, 4914 Delmar Ave., has awarded the contract for installing heating, plumbing and other miscellaneous work in his dry cleaning plant at 5157 Easton Ave., to the Hoffman Heating Co., 5912 Enright Ave. Estimated cost, $10,000.

Mo., St. Louis—Johansen Bros. Shoe Co., 3646 Laclede Ave., has awarded contract for building a 5 story, 53 x 102 shoe factory on 3646 Laclede Ave,, to Western Construction Co., Central Bldg. A steam heating system and boilers will be installed. Total estimated cost, $50,000.

Okla., Norman—The State Board of Public Affairs, Oklahoma City, has awarded the contract for the construction of a 3 story dormitory, to the Manhattan Construction Co., 3rd and Fondulac St., Muskogee. A steam heating system will be installed in same. Estimated cost, $100,000.

Cal., Los Angeles—The Board of Public Service, 645 South Olive St., has awarded the contract for furnishing generators and electrical equipment for power plant No. 2 in the San Francisco Canyon, to the General Electric Co., 728 South Spring St., at $457,505; furnishing and installing hydro-electrical appliances to Wellman-Seaver-Morgan Co., at $203,561.

Cat., San Marino—Henry E. Huntington has awarded the contract for the construction of a 2 story, 160 x 200 ft. library, to W. C. Crowell, 440 Chamber of Commerce Bldg., Pasadena. A steam heating system will be installed in same. Total estimated cost, $175,000.

Ont., London—C. S. Hyman & Co. has awarded the contract for building a 5 story, 150 x 250 ft. factory on St. George St., to P. H. Secord & Sons, Brantford. Steam heating system, engine, boiler, etc., will be installed in same. Total estimated cost, $200,000. Noted Aug. 5.

Ont., Ottawa—Loew's Theatre, Ltd., has awarded the contract for the construction of a 4 story, 150 x 200 ft. theatre, store and office building on Bank and Queen St., to Bates & McMahon, Central Chambers, Elgin St. A steam heating system will be installed in same. Total estimated cost, $450,000.

Are You Interested
in Live Business Propositions?

POWER

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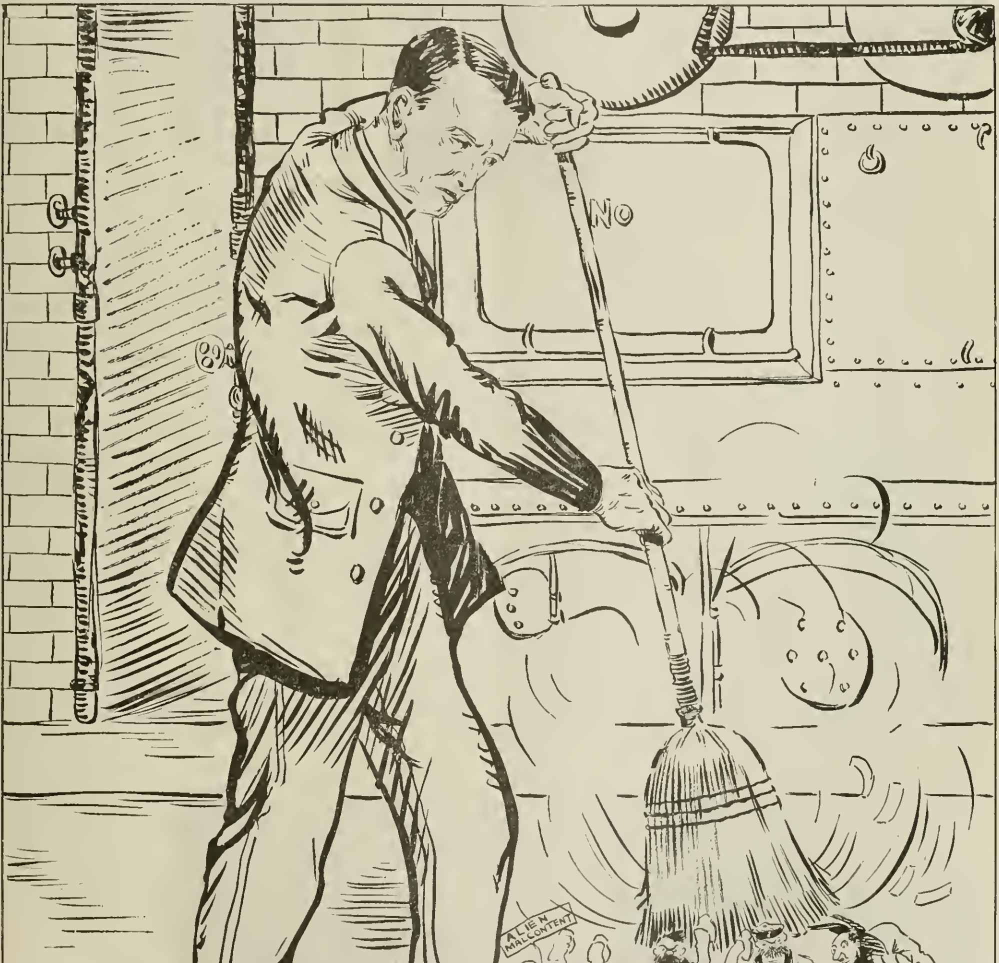


Induction Motors Driving Centrifugal Pumps

By FRASER JEFFREY
Electrical Engineer, Allis-Chalmers Manufacturing Company

THE induction type of polyphase motor is especially well adapted for direct connection to centrifugal pumps not only on account of its simplicity of application and operation, but also by reason of the wide range of output and speed that is obtainable. In the accompanying table are shown the synchronous speeds that may be obtained. The full-load speeds are from 1.5 to 5 per cent. less, depending on the size and type of motor used. Lower speeds than shown are possible, but may be considered as more or less special and therefore have not been listed. There are two distinct forms of induction motor, the squirrel-cage and the slip-ring types, each having certain definite applications of its own and the applicability of one or the other being determined more or less by local conditions and the exact requirements that are to be met. The squirrel-cage motor consists of a primary member, or stationary stator, which carries the coils energized by the source of supply, and a secondary, or rotating member, called the rotor, which carries a number of current conducting bars short-circuited on themselves by means of end rings which are located at either end of the core, as shown by Fig. 2.

With the squirrel-cage motor there is a definite limit to the static or starting torque it will develop. A commercial machine of this type is designed to exert a starting torque, if it were thrown directly on the line, which varies with the number of poles and the speed, in amounts as shown in the table. Except in the case of small machines the squirrel-cage motor cannot be started by connecting it directly to the line. As with the direct-current motor the rush of current is so great as to cause undesirable fluctuations in voltage, excessive demands of current at very low power factor on the generating equipment and dangerous shocks to the motor, pump and pump lines themselves. The average squirrel-cage machine, if thrown directly across the line, will draw a current of from 4½ to 8 times normal, depending upon the inherent characteristics of the particular machine. In starting the general method is to apply a reduced voltage to the primary member and then, when the rotor is up to speed, to throw over to full line voltage. By doing this, the shocks and line fluctuations are greatly minimized, but the starting torque is also reduced in the ratio of the squares of the applied voltage to the normal voltage; that is, if a voltage of one-half normal is first applied, the starting torque will be one-fourth what it would be with full voltage. The general practice is to supply all motors over 5-hp. in size with some form of starting compensator, but for 5-hp. and less it is satisfactory to throw them directly on the line. Fig. 3 shows a typical wiring diagram such as is used in connection with the larger type (200-hp. and above) of squirrel-cage motor. The same thing is shown for the smaller sizes in Fig. 6, while in Fig. 4 is illustrated the form of wiring that is generally in use for motors of 5-hp. and less. While the control for the large motors, shown in Fig. 3, requires a panel, that for Fig. 6 can be mounted conveniently on pipe framework, as in Fig. 7, making a simple and convenient outfit to install. For special cases and where warranted, an automatic magnetic type of control may be used. Such an installation is shown in Fig. 5. An installation of 400-hp. 1200 r.p.m. pumping units with control apparatus similar to that in Fig. 3 is shown in Fig. 1.

SYNCHRONOUS SPEEDS OF INDUCTION MOTORS

No. of Poles	Synchronous Speed 60 Cycles	50 Cycles	40 Cycles	25 Cycles	Starting Torque in Per Cent. of Full-Load Torque for Full Voltage, Squirrel-Cage Motors Only
2	....	....	....	1500	150
4	1800	1500	1200	750	150
6	1200	1000	800	375	135
8	900	750	600	300	125
10	720	600	480	250	120
12	600	500	400	....	115
14	514	428	343	....	110
16	450	375	300	....	105
18	400	333	267	....	100
20	360	300	240	....	100

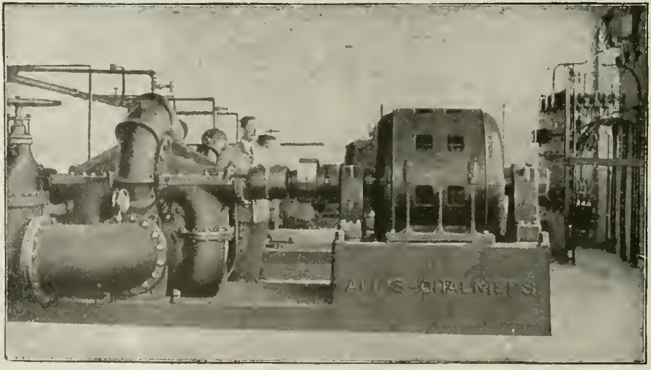


FIG. 1. INDUCTION MOTORS IN IRRIGATION PUMPING STATION

The slip-ring motor has a stator which is the same as for the squirrel-cage machine. The secondary member differs, however, in that it carries a complete polyphase winding, similar to the primary member, the terminals of the rotor being connected to three slip rings as in Fig. 8. By inserting an external variable

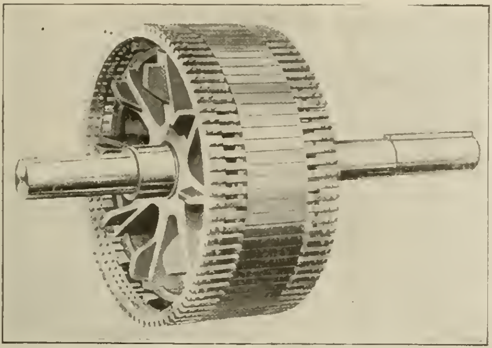


FIG. 2. SQUIRREL-CAGE ROTOR

resistance in the circuit of the rotor winding, the speed for any given load can be varied to meet any required condition; the current taken from the line at starting can be controlled within certain definite limits for any given torque up to the maximum the motor can deliver, and the power factor at starting remains the same as when the motor is running for any given load condition, which is a desirable feature.

Unlike the squirrel-cage motor, the starting torque can be varied and the primary current controlled over wide ranges. The usual method of starting is by inserting such an amount of resistance in the rotor as to obtain full-load to 1½ times full-load torque, with full-load to 1½ times full-load current, the power factor of the circuit remaining the same as if the motor were actually running under these loads. By gradually cutting out the secondary resistance, the motor is brought up to speed, the last notch of the controller short-circuiting the rotor winding. By inserting resistance, the speed of the motor may be varied if the control is constructed for such service. Figs. 10 and 11 show a wiring diagram and panel respectively, used with smaller type of wound-rotor induction motors. In the larger sizes the general practice is to use either a drum type or mutiple-switch type of starter, and if the installation warrants, the full magnetic type of control or the automatic type of liquid control is often used.

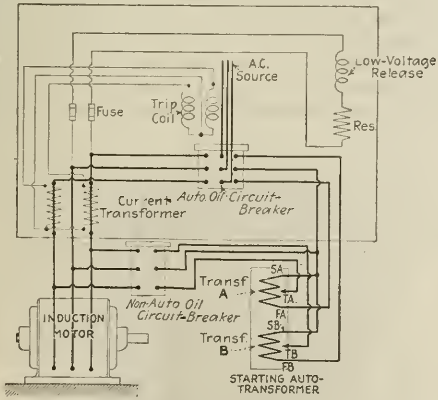


FIG. 3. CONTROL CONNECTIONS FOR LARGE SQUIRREL-CAGE MOTOR

For centrifugal-pump work the squirrel-cage motor is well suited on account of the simplicity of not only the motor itself, but also the control. Usually, the first cost is less than that of the slip-ring type of motor, but there are local conditions that determine more or less which type of machine should be used. The squirrel-cage motor is inherently one of low starting torque with relatively large starting currents, and when used in connection with a pump, there should be some means provided, such as a valve in the discharge line, for unloading purposes during the starting period. If such an unloading device is not supplied, the condition may arise where the motor may not have the necessary torque to start up the pump, and even if it has, the shock to the motor, pump and packing system is most severe when the motor is thrown from the starting to the running position. Especially is this true if, during the starting period, a large head of water has been built up, and if such is the case the shock of throwing over has been known to cause a water-hammer severe enough to break the piping. With the unloading valve, however, these difficulties are overcome, and this type of motor is extensively used in many different kinds of commercial and specialized industries. In addition, the squirrel-cage motor is apt to cause line fluctuations that may be objectionable, and in certain cases the capacity of the generators at the source of supply may be such as to warrant the use of the slip-ring type of machine. Also if a certain amount of speed variation is desired, this can be obtained only by the use of the phase-wound motor with resistance connected in series with the rotor. The resistance for this purpose must be designed to carry full-load rotor current continuously.

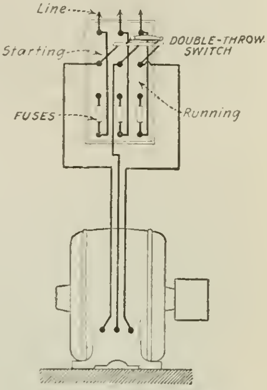


FIG. 4. SQUIRREL-CAGE MOTOR CONNECTED DIRECTLY TO LINE

In the larger sizes of units the slip-ring motor is preferable on account of its ability to start up smoothly against a head or heavy load, drawing a minimum cur-

FIG. 5. VERTICAL SQUIRREL-CAGE MOTORS UNDER AUTOMATIC CONTROL

rent from the line and thus causing small line fluctuations and shocks to the apparatus itself.

In Fig. 9 is illustrated the different current, speed and torque characteristics of the squirrel cage and the slip-ring types of motor. Curves A_c and A_T are the current and speed-torque curves respectively of a squirrel-cage motor, if thrown directly across the line; curves B_c and B_T are the same thing when the motor is started under voltage reduced to 50 per cent. of normal. Curves C_c and C_T are from the slip-ring type of motor with the secondary resistance adjusted to give maximum starting torque, and curves D_c and D_T, the same with the resistance adjusted to give full-load torque at starting, any intermediate points being taken care of by the controller.

A close study of these curves will show the chief points of difference between the two different types of motor. It should be specially noticed that the limit of current in the slip-ring motor is dependent upon the amount of secondary resistance, and for this reason the current curves C_c and D_c do not extend farther than shown.

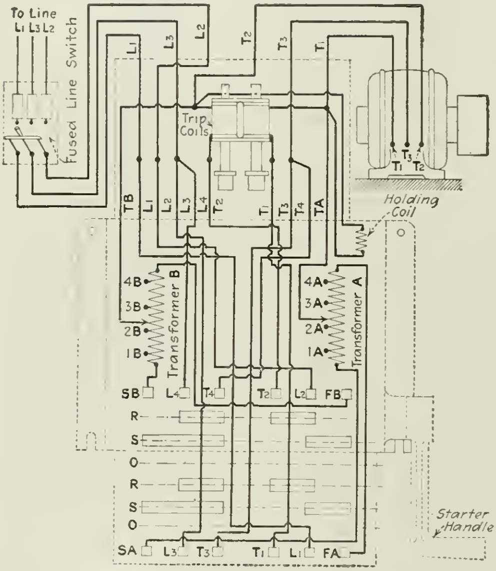


FIG. 6. CONTROL CONNECTIONS FOR MEDIUM-SIZED SQUIRREL-CAGE MOTORS

If no external resistance were inserted in the secondary circuit, the current curve would follow closely or on top of that for the squirrel-cage motor. It should be borne in mind, however, that a slip-ring type of motor without external resistance in its secondary circuit will produce practically no starting torque and will tend to lock in the stand-still position. The curves in Fig. 9 have been drawn, not from actual tests, but relatively, to show more clearly the difference between the two kinds of motor.

When installing a motor-driven pumping unit, all wiring must be done in accordance with the rules of the Underwriters' Inspection Bureau having jurisdiction in the particular district in which the apparatus is located. Potential starters, speed controllers, panels, etc., should be set up convenient to the motor, so that not only will all connecting leads from the control to the motor be as short as possible, but the motor can be seen when the operating mechanism is being used.

Assuming that all wiring connections have been carefully checked, it is well to see before starting that the oil wells and bearings are free from dust and grit; that the oil rings turn freely; that the oil, which should be a good grade of dynamo oil, is at the proper level; that the alignment is such that the unit turns over freely and without binding, and in the case of slip-ring type motors that the brushes on the slip rings make good contact to the full area of the brush. When necessary to true up the brushes, a fine sandpaper may be used and the sanding done relative to the direction of rotation of the motor. In cases where no interlock is used between the secondary starter of a slip-ring motor and the primary oil switch, it is most important to make certain that the handle of the rotor starting resistance is in the starting position before throwing in the primary switch. If this is not done, the motor will short-circuit the line and considerable damage may occur.

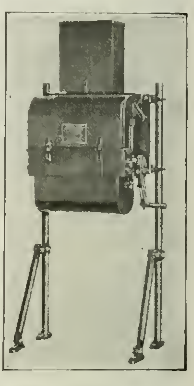


FIG. 7. STARTER FOR SQUIRREL-CAGE MOTOR

When starting for the first time, it is advisable to run the unit without load in order to verify the points brought out in the foregoing. If the motor runs in the wrong direction, the rotation may be reversed by changing the primary leads; for a three-phase motor, interchange any two connections of any phase; for a two-phase motor, interchange any two connections of one phase only.

In starting the squirrel-cage motor provided with a potential starter, the handle is moved from the "off" position to the "starting" position, and after the motor has come up to speed, it is thrown to the "running" position. The handle should be moved quickly when passing from one position to the next, but should be allowed to rest for a short interval on the starting position, or in each position if the starter has more than one starting point, in order to give the motor time to come up to

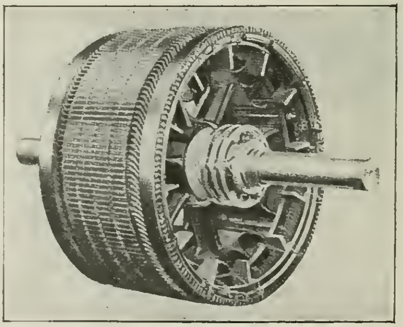


FIG. 8. ROTOR OF SLIP-RING INDUCTION MOTOR

speed. In no case must the starter be held on the starting position for more than one minute, otherwise the starting transformers may be injured. If the motor does not start readily, the transformer taps may be changed to give a higher applied voltage; on the other hand, if the motor starts with an excessive jerk, the applied voltage should be reduced.

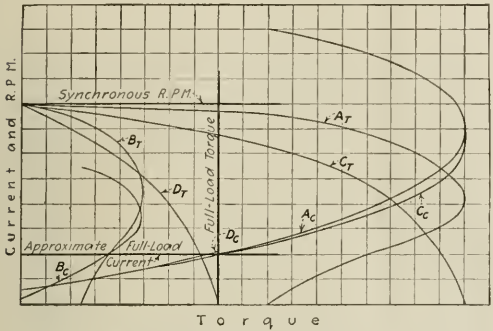


FIG. 9. CURRENT, SPEED AND TORQUE CURVES OF INDUCTION MOTORS

In starting the slip-ring motor the primary switch is first closed, after which the handle of the starter is moved step by step, allowing the contacts to rest a few seconds on each segment, the time depending a great deal on the nature of the load, until the running point is reached, where all resistance is cut out. On controllers for starting duty only, care must be taken not to leave the handle on any of the starting points, or else the resistance may become overheated, with consequent troubles developing. Under ordinary conditions it should not take more than 20 sec. to bring either of the two types of motor up to speed, provided the pump is unloaded when starting with the squirrel-cage type of machine.

On account of their inherent characteristics induction motors are made with relatively small clearances between the rotor and the stator. The greater the air gap is made the lower the power factor becomes, so that the clearances are made such that from an electrical standpoint the power factor remains high, while from a mechanical standpoint the operation is reliable. This clearance, called "air gap," is usually measured in thousandths of an inch, and occasional inspection of bearings and air gap is advisable to make sure that the shaft has not more than the usual allowance of clearance in the bearings and that the rotor is central with respect to the stator.

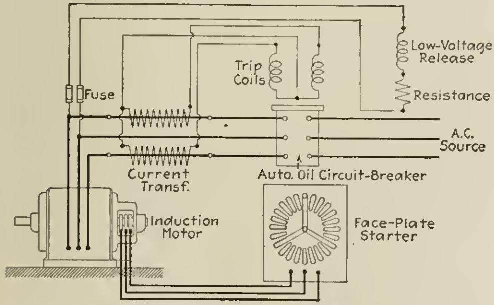


FIG. 10. CONTROL WIRING DIAGRAM FOR SLIP-RING TYPE INDUCTION MOTOR

A temperature rise of from 40 to 50 deg. C., or 70 to 90 deg. F. above the surrounding air is the usual allowance on all the windings and laminations of induction motors when operating at normal load, and there is no occasion for alarm if any part of the motor feels hot to the touch. All parts become warm after a time and a motor may feel hot and still be well below the allowable temperature. At the same time any abnormal temperature rise should be investigated and the cause determined with as little delay as possible. To obtain full output and satisfactory service from an induction motor, it is essential that the line voltage and frequency be not allowed to drop below the rated values for which the motor is designed.

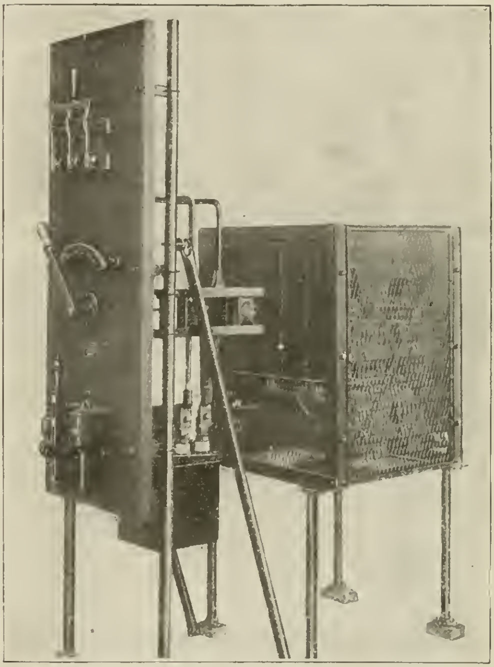


FIG. 11. CONTROL FOR LARGE SLIP-RING TYPE INDUCTION MOTOR

Shanghai, China, is rapidly developing into a progressive industrial and manufacturing center. Practically all textile and flour mills established during the last five years are run by electricity purchased from the municipality, and even some of the older mills are installing motors.

Interesting and important experiments are being carried on in England in connection with the utilization of the airplane engine for ordinary commercial purposes. By making an alteration in the carburetor it is possible to run the engines on coal gas, and they have been connected to dynamos with very good results. While second-hand airplane engines have a limited market, it is believed that as stationary power units they will prove a useful innovation.

Making a Packing-House Refrigerating Plant Carry Its Load

By J. C. MORAN

Unable to put more coil surface in the coolers, brine circulation over the direct expansion coils was provided and the temperatures lowered and maintained.

WHILE overhauling a small ice plant in the South, I received a visit from the troubled owner of a small packing plant which could not do the work required of it. It was a case of either building more coolers and buying more machinery or trying to improve what he already had. Everything was working up to the limit and still the cooler temperatures were ten to fifteen degrees too high. A considerable increase in output was expected during the coming summer.

The system was direct expansion throughout. A large hot-beef cooler and a storage cooler were on the second floor. On the floor below were the wholesale market and two small freezers. The coils were hung on the walls in all the rooms. All piping was covered with several inches of frost, as usual. This we soon got rid of by installing a hot gas connection to the liquid line by which we could put hot gas from the discharge line into the coils at regular times. The hot-beef cooler and storage cooler were still at too high a temperature mainly because there was not enough cooling-coil surface.

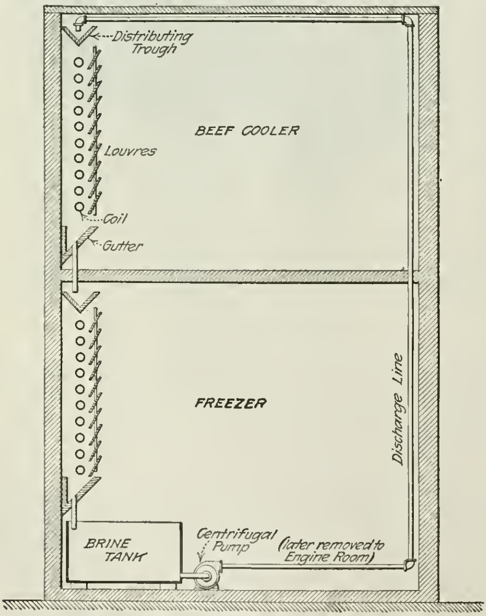


FIG. 1. SHOWING COILS AND DISTRIBUTING TROUGHS

The freezers and the wholesale market had an abundance of pipe, and here there was no trouble to maintain the temperatures after the coils were cleaned. To make use of all the rails on which the beeves were hung, it was impossible to add more coils because the meat would then be hanging against the coils and freeze to them. If we did not use the rails next to the coils, it would mean a reduction of capacity of about 50 head per day, which again could not be tolerated.

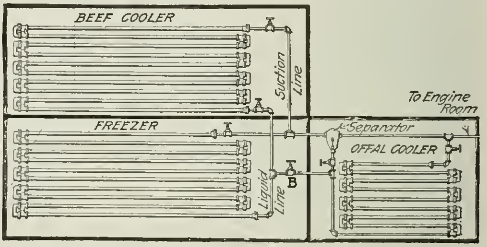


FIG. 2. CONNECTIONS TO COOLER AND FREEZING COILS

I did some "tall" thinking on this problem for a couple of days until I remembered reading that one fellow had solved a somewhat similar problem by providing brine circulation over the coils in the rooms where the piping was inadequate. I decided that this was worth trying. We bought a few galvanized distributing troughs such as are used on atmospheric condensers, and these were hung above the coils on one side of the room. Another set was hung above the coils on one side of the room in one of the freezers down below.

Trying the Experiment

A small centrifugal pump was borrowed from the ice plant and installed in the freezer in connection with a small tank into which the brine collected after it left the coils. Everything was now set for the experiment, pipes having been connected from a trough under the coils in the freezer and the hot-beef room, the pipe from the trough in the freezer leading to the collecting tank to which the pump was connected, the pipe from the coils in the hot-beef room were led down through the floor to the distributing trough above the freezer coil. Canvas strips were hung in front of the coils to prevent the brine spattering out on the floor. A temporary pipe connection was run from the discharge side of the pump to the distributing trough above the one coil in the hot-beef cooler. By this arrangement the brine would first pass over the coil in the hot-beef room, collect in the trough under the coil and run down through the pipe connection to the freezer coil below and over this into the trough under this coil, from which it was led to the collecting tank and again started back over the same route.

We procured some calcium and prepared sufficient brine to fill the collecting tank and started the pump. After some trouble adjusting the distributing valves above the troughs, the arrangement worked well. The suction pressure increased considerably, the freezer temperature even went down a degree or two and the hot-beef room temperature dropped several degrees during the afternoon while the cooler was filling, which was unheard of before.

DETAILS OF THE FINAL CONSTRUCTION

Both the owners and myself were so satisfied with the experiment that we decided to make it permanent. Fig. 1 illustrates the final construction. A small motor-driven centrifugal pump was installed in the engine room and connected to a collecting and storage tank in the freezer, the discharge from the pump led through several branches to troughs above each of the coils in the hot-beef cooler and storage room. The brine, after circulating over the coils in these coolers, collected in gutters beneath the coils and passed through connecting and distributing pipes to the freezer coils below. After passing over these it returned to the storage and collecting tank.

To prevent the brine spattering over the floor and also to aid in the best possible manner the circulation of the air, wooden louvers, as indicated in the sketch, were placed close to the coils. The sketch illustrates the arrangement for one side of the room only. In the finished job all the coils were arranged the same way.

To give more space in the beef coolers, a small offal cooler had been built next to one of the freezers. The coils had already been installed in this, but had not been connected to the suction or liquid lines. Here I made use of another "wrinkle" that I had noticed while on a visit to a small cold-storage plant.

STEAM SEPARATOR INSTALLED

A large steam separator was installed in the suction line, as shown in Fig. 2. The drain outlet was connected to the bottom of the offal cooler coil, as shown, and the other end to the suction in the regular way. A common stop valve was placed in the pipe from the separator, as indicated. A connection to the liquid line was also made and an expansion valve installed at *B*, through which liquid could be fed in the regular manner if desired.

The purpose of this construction was to flood the rest of the coils, particularly in the beef rooms where the coils were too small, and thus work them to their maximum capacity, as in a flooded system. The separator in the suction line would separate out all of the liquid carried back in the suction gas, and this would drain down into the coil in the offal cooler. It then became a simple matter of flooding one or more coils sufficiently to supply enough excess liquid to keep the offal cooler working at the right temperature.

CHANGES PROVED SATISFACTORY

When completed, the plant worked very well. The brine circulation over the coils kept them clean and insured maximum heat-absorbing capacity. The brine circulation over the coils improved the air circulation in the coolers and eliminated a large amount of the dampness in the beef coolers. In case the beef coolers were heavily loaded, we circulated the maximum amount of brine, which threw a large portion of the work on the freezer coils, which had abundant capacity. In this manner we could draw on the heavy freezer coils for reserve capacity for the beef coolers, and this gave ample capacity for the heaviest loads. At the same time we could rapidly lower the freezer temperatures by cutting down the brine circulation and leaving the freezer coils in their clean condition, working practically on the freezers alone.

The offal cooler connection with the separator in the line was a further improvement. We adjusted the expansion valves on the beef coolers in particular so that they threw considerable liquid back into the suction line, thus insuring that they were working at full capacity. The coils in the wholesale market and the freezers were also adjusted to throw an excess into the line, thus insuring maximum capacity from all the coils as long as the offal-cooler coils were supplied with liquid caught in the separator.

ENGINEERS PLEASED WITH NEW ARRANGEMENT

After the system had been run a few days, the engineers became accustomed to it and liked the arrangement. The expansion valves on all the coils were opened a little at a time until the excess liquid carried back in the suction gas was greater than needed by the offal cooler. The main valve in the liquid line in the engine room was then throttled until the discharge temperature of the machine was high and the frost line carried back to the best operating position on the machine. As long as this condition obtained we knew that all the coils, including the offal cooler, were operating at maximum capacity. In case it became necessary to cut off the offal cooler when the temperatures became low, it was a simple matter to throttle the valve in the line from the separator to the coil, which cut off the feed to it and then further throttle the valve in the liquid line in the engine room to take care of the excess that would not be taken care of by the offal cooler.

ECONOMY AND CAPACITY INCREASED

The increase in operating economy and capacity was surprising. Where before they had been running with a suction pressure of about zero, beef-cooler temperatures as high as 45 deg. every morning and freezer temperatures of about 25 deg., they were now able to handle the load with a suction pressure of about 20 lb., the beef coolers were down to 33 or 35 deg. every morning and it was a simple matter to hold the freezers at 15 deg., even while they had to help to carry part of the beef-cooler load by cooling the brine that came down from them and was circulated over them again after it had been cooled by passing over the freezer coils and coming in contact with the low temperatures in the freezers. Also, where it had been necessary to run two 50-ton machines as fast as possible all the time, it was not required to run the two machines only a small part of the time.

Mill to Burn Powdered Coal

Powdered coal is to be used throughout for firing boilers and furnaces in the new sheet mill of the Falcon Steel Co. now being erected at Niles, Ohio. The power-plant boilers will be powdered-coal fired, using the Quigley compressed-air system for transporting and burning the coal. The pulverized coal will be transported from the milling plant through standard 4-in. diameter wrought pipes to furnaces and boilers for various distances aggregating approximately 800 ft. and will be switched from the main distribution line to a storage bin in the power house for use as required.

Power-Plant Operation on an Efficient Basis

By PAUL R. DUFFEY

Inefficiencies tending to increase the unit cost, can easily creep into the production of heat, power and light for the average power plant of the railroad terminal or the factory. This article deals principally with the power plant of the railroad terminal.

PECULIAR conditions in railroad-shop work render close supervision of power production very essential to reasonable cost of operation. Usually, the terminal power plant, in addition to furnishing steam for driving the air compressors, engines, feed pumps, etc., must supply steam for the drafting of locomotives, heating buildings, drying sand, thawing coal and furnishing power for the testing of lubricators, injectors and air pumps. The load to be carried is as a rule variable through a wide range, and the plant as usually designed or reinforced to meet the maximum requirements operates at a low efficiency during a greater portion of the time in order to be prepared for emergencies that continually arise.

LACK OF MEANS FOR DETERMINING POWER

The principal difficulties encountered in investigating power-plant losses is the lack of means of determining the power of the various classes actually being generated and consumed. City gas and water companies producing a commodity for sale to the community find it to their interest to install suitable apparatus for measuring their commodity to the consumer, even though the monthly consumption in many cases would not pass the dollar mark. Such companies must know exactly how much it is costing them to operate and produce their commodity for sale in order that they may set an equitable price that will allow them a profit and enable them to compete with other companies. It may be argued that a plant generating power for its own use need not go to the expense of installing meters or other forms of efficiency checks, as the expense of operating the plant must be carried in the overhead charges, and that information as to amounts used or costs are superfluous.

Meters of the proper types are essential to efficient power generation, and their use provides definite knowledge that maximum economy is being obtained. But, whether meters are provided or not—and in the majority of cases they are not—there are a number of items that contribute to inefficient power-plant operation and that may be controlled wholly or in part by systematic supervision. These items, which are common to a large percentage of power plants, but particularly to the railroad terminal plant, may be classified under the following heads: Improper operation of power units; steam, air and water leaks; waste of power delivered, fuel and labor.

IMPROPER OPERATION OF POWER UNITS

One of the most serious problems of the chief engineer is to operate his equipment at maximum efficiency under existing conditions. If the equipment is not adapted to the plant and is only about 50 per cent. of that required, it is up to the chief to get that 50 per cent., though by so doing he is getting the maximum or 100 per cent. If at the other end of the city a similar plant is getting only 25 per cent. out of its 50 per cent. equipment, the result obtained is 50 per cent. quality at the second plant. Therefore, efforts should be directed toward obtaining from the equipment the maximum economy. This cannot be done unless the equipment is kept in the best possible repair. By way of illustration, one will often find the electric-generator engine pounding badly in the main crank bearing and running hot on the outboard bearing. Such a condition lessens the output of the machine and makes the steam consumption excessive. It will hardly develop at one time, but is the result of neglect of a minor repair on the operator's part. The cost of repairs once machinery reaches a dangerous state is as a rule high and must be figured in the final cost of the power delivered.

CHECKS ON COST OF POWER

It is not uncommon to see an air compressor running at maximum speed and with an unnecessarily high steam consumption, to keep up the required air pressure against such handicaps as leaky pipe lines, leaky pneumatic hose, tools practically past the state of usefulness and leaky or sticking suction and discharge valves on the compressor itself. Thus, only a fraction of the work being performed by the compressor is useful. Such conditions are inexcusable and can be traced directly to the absence of systematic checks on the cost of power. The compressor or any of its allied equipment which, through lack of attention, does not keep up to the required duty, contributes directly to the inefficiency and waste of every air appliance in the plant, and the poor tool in turn reduces the effort put forth by the workman in its operation.

The popular excuse given for neglect is that an opportunity is not readily to be had for making repairs. To overcome this there should be auxiliary equipment so as to allow for a change over of machines. Even where no such equipment is provided, the chief engineer can usually figure out a way to obtain the necessary time to make repairs. A shutdown of the entire plant for a short period may in the end prove to be a measure of economy.

STEAM, AIR AND WATER LINE LEAKS

One of the greatest sources of excessive power cost is traceable to the loss of generated power without the production of useful work. By this is meant that the long lines of steam, air and water piping which convey water or heat from the station to the departments of the plant frequently waste more through leakage, condensation and friction than they deliver for effective use. Pipe lines should be so arranged as to provide adequate protection from the elements and accessibility for repairs, and in general layout the minimum distance of transmission should be given very careful consideration.

Around the railroad terminal the worst offenders in the matter of pipe lines are the car-repair yards and the engine house, for in many cases the lines must be placed in positions which allow them to be eaten up by corrosion and rust or broken and otherwise damaged. To provide for adequate protection a detailed study should be made as to insulating the pipe. Inspection of almost any plant will demonstrate the necessity of careful attention to all pipe lines, particularly those under ground. It is not the large leaks which account for having to put on another boiler, compressor or pump; instead, from 25 to 50 per cent. of the power is wasted through lack of supervision of the small things. Leaks in the low-pressure steam or hot-water heating system should be repaired and all traps and returns put in good order, for here alone the saving to be made will pay for many tons of fuel.

Waste of Power Delivered

In passing through the shop one may possibly observe a mechanic drilling holes in a cylinder saddle after it has been placed in position on the locomotive. To do this work he has rigged up a portable pneumatic drill and is having more or less trouble in getting the holes drilled. The air connections to the hose at the main air-supply line and at the drill are leaking badly, the hose has several pinhole leaks, and the drill is so dull that it will not take hold properly. With conditions like this the man doing the work will consume enough time in drilling one hole to have drilled three had conditions been more in his favor. While such waste of delivered power cannot be controlled by the power-plant force, considerable economies may be obtained, by securing the coöperation of the foreman toward reducing such waste to a minimum.

Waste of Fuel

In the average boiler room it will be observed that along the firing aisle in front of the boilers a quantity of coal has dropped off the scoop on its way to the furnace. This coal is soon ground under foot and finds its way to the ash dump. The loss, though only a small one, is readily observable, yet it should not be ignored for other and larger losses that cannot be so readily seen.

Some of the principal losses are due to improper design of the plant equipment, failure to keep the internal and external heating surfaces of the boiler free of scale and soot accumulations and failure to keep baffle walls, furnace walls and other parts of the boiler setting tight and in first-class condition. A part of such losses are inevitable, but in many cases loss may be eliminated by careful supervision supported by accurate checks of the fuel used in proportion to the steam generated. The most modern boiler and stoker equipment and the antiquated hand-fired equipment may be considered on a par unless in each case there are proper means of checking the coal consumed, water evaporated and steam generated. Even with efficient methods of checking installed, unless the management of the plant is systematic there will be much waste, and the benefits to be derived from expensive checking equipment will be lost or of little value.

Firemen Should Be Carefully Instructed

In stationary boiler plants firemen should be carefully instructed as to the best methods of firing and handling the boilers and the supervision should provide against letting the firemen get into a rut. Standards for firing should be set and then followed closely. The fuel used, design of boiler and furnace, draft on boilers, load to be carried and other numerous items must in a large measure govern the standard adopted at any particular plant; and that standard which will readily prove to be the best can be determined only by intelligent trial and advice from the plant engineer.

Another point that has quite a bearing on efficiency is the number of boilers being fired unnecessarily. When three or four boilers are being fired to do the work required of two, the fuel waste is excessive. It will be found economical to keep a close check on all power requirements at different periods of the working day, as this information will enable the boilers on the line to be worked as nearly as possible at their full rated capacity at all times.

Perhaps the greatest waste of labor at the majority of power plants is due to poor management, poor facilities for conveying the fuel to within easy handling distance of the fireman and a lack of proper and efficient methods of ash disposal. Improvement can be made in arranging coal bunkers, without adding to the difficulties usually experienced in unloading cars, to feed the coal directly to the firing floor so that the man with the scoop can shovel it into the furnace without having to take several steps and stoop low at every scoopful fired.

Waste of Labor

It is a good plan to go into the boiler room and watch the men. Every unnecessary step the fireman must take decreases his effort, and even though he takes only one or two extra steps for each scoop of fuel fired, this total waste of energy in a month or a year reaches surprising proportions. The man who is really overworked or doing unnecessary work it not an efficient workman, and many cases of poor firing are due more or less to the fact that lack of proper facilities for performing the work has led men to adopt practices that are wasteful of both fuel and labor. Much more along this line could be said but if the reader will avail himself of a copy of Technical Paper No. 80, "Hand Firing Soft Coal Under Power-Plant Boilers," published by the Bureau of Mines, there is no doubt that much practical information can be obtained, which, if properly applied, will tend to reduce the labor waste around a plant to a minimum.

To keep the business end of the plant on an efficient basis it is necessary to see that suitable records of performance are kept each day and that such records are always available for comparison. The system of records and a check on the plant performance should be such that no item, no matter how small, should escape unnoticed by the engineer in charge of the plant. Such records are available only by using the chief engineer's time in such a manner that he will not waste his labor in doing the things that should have been done in getting out the design for the plant.

Of all the big producing countries, the United States has by far the lowest price per ton for coal production, says the American Chamber of Commerce in London. According to an official statement made upon request by the Board of Trade in Parliament, the comparative prices per ton of coal at the pit head in England and Scotland, America and Europe, average as follows for the latest periods for which particulars are available: Scotland (including six per cent. increase), $6.94; rest of Great Britain, $7.04; U. S. A., June, 1919, $2.68; France, June, 1919, $8.64; Belgium, 1917, $4.32; Spain, 1917, $9.36.

Coal Analyses Made at the Power Plant

By E. D. HUMMEL

A method that obviates the necessity for sending coal to a chemist and gives accurate results promptly. The work can be done by a woman and apparatus costing $300.

COAL analyses are rapidly becoming a necessity in power plants because the best grades of coal go to the stations that have the facts. Moreover, it is now becoming more general practice to consider plant-efficiency records in terms of British thermal units per kilowatt-hour instead of pounds of coal per kilowatt-hour. This latter tendency is advantageous to the operating company and the plant engineer alike, because it gives a fundamental basis for discussing efficiency upon which there can be no misunderstanding. The practice would no doubt have grown faster had it been easier to make proximate analysis of coal. The chief reason for making the coal tests at the plant, however, is that the results can be secured in a few hours after the sample has been received, whereas it may be a matter of days if samples must be sent to a chemist. Getting the data thus promptly permits the engineer to work up operating results based on actual tests of the coal fired instead of results based on analyses of coal handled a week previously which was supposed to be the same. Many plants use the latter method, but there are cases where the results so secured have been found to be misleading.

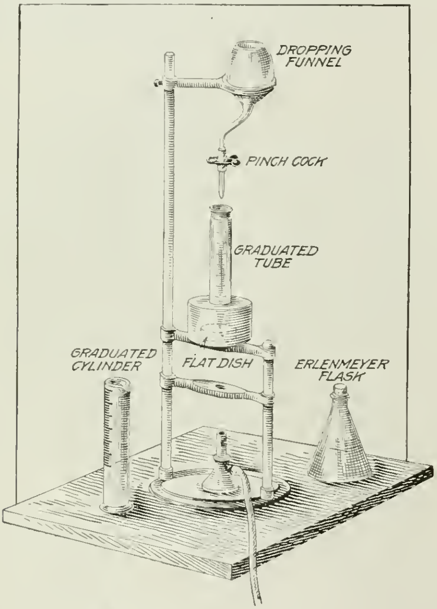


FIG. 1. SOME OF THE APPARATUS REQUIRED

It is usually considered that a chemist is required to determine the number of B.t.u. in a pound of coal. Modern apparatus, however, renders this determination relatively simple, much more so than the average engineer realizes. In fact, the work can be outlined in such a manner that the layman can handle it. The following article describes a simplified method of analysis in power stations to determine the quality of the coal used without sending it to a laboratory.

A manipulator does not have to be a skilled chemist to make a proximate analysis of coal by this method. Any person who is able to calculate, to take temperatures and to weigh, and who possesses a fair degree of common sense, may obtain good results after a little practice. Practice and accuracy in taking readings are the prime factors in getting a final result that may be relied upon.

The following is a tabulation of apparatus required to equip a power station laboratory for the purpose of analyzing coal.

1	Parr standard calorimeter
1	Electric stirring motor—specify whether to be used with 110 or 220 volt d.c., or 110 or 220 volt a.c.
1	Bank of resistance for 110 or 220 volts
1	Hot-air oven
1	Thermometer 0—400 deg. F. for oven
1	Mortar and pestle
1	Balance scale—Becker or equivalent
1	Set of metric weights
1	Desiccator, 6 or 8 in.—Sheiblers or equivalent
1	Bunsen burner
1	Support
4	25-c.c. porcelain glazed crucibles
2	Steel spatulas
1	Crucible tongs
3	2½-in. iron triangles—pipe stem covered
1	Balance scale for coarse weighing—capacity 5 lb.
3	Beakers—200 c.c.
2	Beakers—25 c.c.
1	Parr sulphur photometer

Several pieces of apparatus not mentioned in the list are furnished with the calorimeter and photometer. All the apparatus will cost about $300. The money thus spent will soon be returned, however, if many samples of coal are to be analyzed.

For sampling and preparing the coal, methods described in the Government's Technical Paper No. 133 should be followed. (Fully described and illustrated in *Power* for Apr. 2, 1918, page 476.) The coal sample "as received" should be delivered to the laboratory in a container tightly sealed, having a capacity of two pounds or three pounds.

The first step in analyzing coal is to determine the moisture content. This is done in two operations: First, air drying, then oven drying: To obtain the percentage of moisture in the coal, empty the contents of the container on a square of stiff paper which has been previously counterpoised and weigh it. Allow the coal to stand in a current of air warmed to from 80 deg. to 100 deg. F. for a period not less than twelve hours. Then weigh it and compute the percentage of moisture by this formula:

$$\frac{\textit{Weight moist coal} - \textit{weight dry coal}}{\textit{Weight moist coal}} \times 100 = \textit{per cent. moisture} \qquad \overline{(1)}$$

When the sample lot has been reduced by quartering to about 1 oz. to 1½ oz., grind it in the mortar until it will pass through a 100-mesh sieve. This must be done rapidly to avoid any loss of moisture during the process.

Weigh out 5 grams of the powdered coal and put it in a 25-c.c. crucible. It is well in doing this to counterpoise the crucible on the balance and weigh the coal directly in the crucible, thereby eliminating any loss of coal by transferring it from the balance pan to the crucible. Dry it in the oven for one hour at 220 deg. F. After this, cool it in the desiccator and weigh it. The loss indicates the amount of moisture in the air-dried coal. To calculate the percentage of moisture use formula (1).

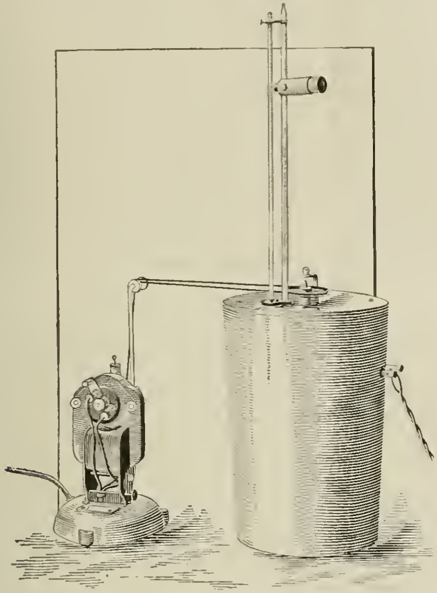


FIG. 2. CALORIMETER READY FOR TEST

Volatile Matter Also Determined by Heating

To determine the amount of volatile in the coal, weigh out one gram of the powdered coal in a 25-c.c. crucible after counterpoising the crucible. A platinum crucible is preferred, but one of porcelain will do. The volatile determination is similar to the moisture determination, but is made with the temperature at red to white heat and with the careful exclusion of air. If the coal is not very moist, as is the case of oven-dried coal, it is necessary to wet it slightly after weighing it in the crucible. This allows the air to be expelled from the crucible and prevents the oxidation of the coal. A piece of asbestos paper somewhat larger than the top of the crucible can be used between the edge of the crucible and the lid. This, being weighted down, acts as a check valve allowing the gas to pass off but preventing the ingress of air.

When these preparations have been made, heat the crucible with a bunsen burner capable of raising the temperature to a white heat. Heat it slowly for the first five minutes while expelling the air, then heat it to the limit of the burner for 15 to 20 min. It is well to have a metal chimney around the flame to avoid the effect of drafts of air. At the end of the heating period cool the test sample in a desiccator with the lid on. When it is cool, remove the lid and inspect the contents of the crucible to determine the coking power of the coal. Weigh and calculate the percentage of volatile matter by formula (2).

$$\frac{\textit{Weight of residue}}{\textit{Weight of coal}} \times 100 = \textit{percentage volatile.} \quad (2)$$

The process of ash determination is somewhat like the process of finding the percentage of volatile matter. The first step is to weigh out one gram of the powdered coal in a 25-c.c. crucible after counterpoising and weighing the crucible. Then place the crucible about three inches above the flame of a bunsen burner, the flame being about three inches in height. Allow it to remain in this position for 15 min. to permit the volatile matter to pass off, then lower it well down within the flame, leaving it in this position until observation shows a clean ash. This observation is important as the ash determination is very slow when the coal is burned in the open, depending on the atmosphere for the supply of oxygen. Cool it in the desiccator and weigh it. Calculate the percentage of ash by formula (3).

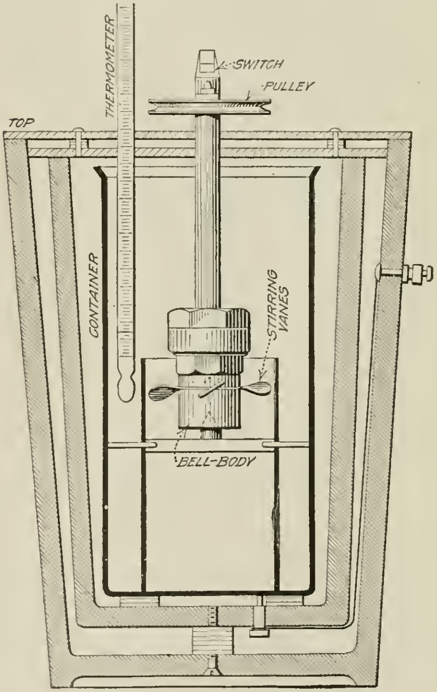


FIG. 3. SECTION OF COAL CALORIMETER

$$\frac{\textit{Weight of ash}}{\textit{Weight of coal}} \times 100 = \textit{percentage ash.} \quad (3)$$

To find the percentage of fixed carbon, subtract from 100 per cent. the sum of the moisture, volatile and ash percentages.

Determination of the heating value is made by a Parr standard calorimeter. In preparing the charge, weigh out one-half gram of the oven-dry coal. In transferring the coal from the balance pan to the fusion cup great care must be exercised not to lose any particles of coal. Before transferring the coal to the fusion cup, see that it is clean and dry. Weigh out one gram of accelerator ($KClO_3$). If the accelerator is lumpy, it must be pulverized on a piece of glass with a spatula, preferably before weighing. Transfer the accelerator to the fusion cup with the coal. Then close it with the false cap and shake it vigorously for five minutes to insure a positive mixture. After it is well mixed, add one full measure of sodium peroxide (NA_2O_2), using the measure furnished with the calorimeter.

In filling the measure it should be tapped to insure complete filling. This must be done rapidly as the peroxide will absorb moisture. In adding the peroxide to the contents of the fusion cup, incline the fusion cup slightly to avoid blowing out the particles of coal. When the peroxide is added, close the cup again with the false cap and shake it, using the same precaution to get a good mixture. After it is well mixed, tap the false cap to remove all particles of the mixture from the upper part of the cup. Then prepare the ignition stem by attaching a piece of fuse wire about 2.7 in. (7 cm.) long to the terminals, passing it through the eyelets. Tighten it to insure good contact, allowing the loop to extend from three-eighths to one-half inch below the central terminal. Remove the false cap from the fusion cup and replace it with the ignition stem. Place the floating bottom at the lower end of the bell-body; place the fusion cup in the bell-body and insert the ignition stem; screw it down tight with the two wrenches. Put on the stirring vanes, allowing the small holes near the lower edge of the bell-body to be exposed. Remove the can from the calorimeter and fill it with 2 liters of water, preferably distilled. This water should be at a temperature of one or two degrees below that of the room. The room temperature should be, if possible, about 70 deg. to 80 deg. F. in order to keep well within the range of the thermometer. Place the container and top in place and see that the thermometer extends a little over halfway to the bottom of the container. Place the pulley in position on the stem, which should then be connected by a light flexible cord to the motor. The stirring is effected by the vanes on the bell-body. The pulley should be revolved in a clockwise direction at about 150 r.p.m Set the switch, being careful not to allow it to touch the ignition stem until the proper time. Allow the unit to revolve a few minutes before taking readings on the thermometer. Take the readings one minute apart for four or five minutes before igniting the charge, to insure an equalization of the temperature. To ignite the charge it is well to throw in the switch with a long stick to insure safety. After igniting the charge the temperature should begin to rise immediately. Take readings at one-minute intervals for nine or ten minutes. The readings must be carefully taken. If the temperature of the water before igniting is one or two degrees below room temperature, the temperature at the end of the first minute after ignition will be something over the room temperature and the radiation for that period may be considered self-correcting. Ordinarily, the rise in temperature will continue for four or five minutes, at which time the maximum will have been reached.

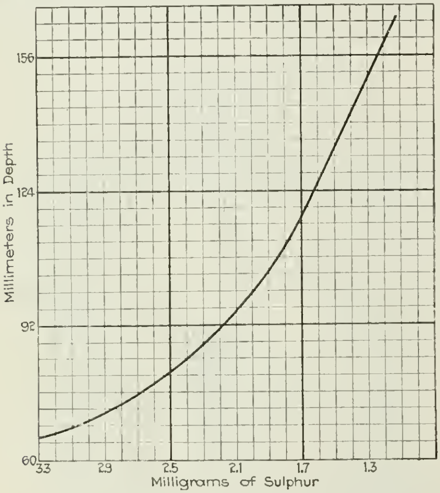


FIG. 5. SULPHUR PHOTOMETER CURVE

How To Find the Radiation

The radiation for this period is found as follows: Read the fall of the temperature for each minute for four or five minutes after the maximum has been reached. The average drop per minute represents the correction to be added to each minute preceding the maximum, except the minute immediately following the ignition. The final temperature thus corrected for radiation minus the initial temperature of the water represents the total rise in temperature.

From the total rise in temperature, corrected for radiation, subtract the correction factors for heat due to chemicals, fuse wire, etc. These correction factors are given in one of the tables. Then multiply the remainder by 3100 (the constant on the calorimeter). The product will be British thermal units per pound of coal.

It should now be noticed that the heat value of the coal as derived, refers to the coal in the condition in which it was weighed out for making the determination. That is to say, if coal having 14 per cent. moisture is oven dried before weighing out the portion for the calorimeter, the determination is for dry coal. To reduce this calculation to an "as received" basis, divide the number of B.t.u. obtained by 100 per cent. plus the percentage of moisture present in the coal obtained by determination.

TABLE OF CORRECTION FACTORS FOR CALORIMETER

	Deg. F.
Percentage ash, multiplied by	0.005
Percentage sulphur, multiplied by	0.010
Fuse wire	0.005
Accelerator, 1 gr.	0.270
Hydration, bituminous coal	0.070

Sulphur Content Found by Photometer

Determination of the percentage of sulphur in coal can be made by a Parr photometer. To obtain the sulphur content by this method, the residue from the fusion cup of the calorimeter is used. The first step is to place the material from the fusion cup in a large beaker after the cartridge is dismantled and pour hot water over it. In all add about 150 c.c. of water. Heat the mixture for five to ten minutes, then cool it and add enough pure concentrated hydrochloric acid (HCl) to neutralize the solution. Then add 5 c.c. of acid in excess.

Transfer the slightly acid solution to the 250-c.c. flask and fill it up to the 250-c.c. mark with pure water. Mix it thoroughly and then measure out for the analysis 25 c.c. of the solution in a graduated tube having a capacity of 100 c.c. Fill it up to the 100-c.c. mark with pure water. Transfer the 100 c.c. of solution from the cylinder to the Erlenmeyer flask and add 0.3 to 0.5 gram of barium oxalate powder, and without delay close the flask with the cork and shake vigorously for three to five minutes. Then allow it to stand for fifteen minutes.

To secure the turbidity, the solution is shaken and poured from the flask to the dropping funnel. The graduated tube is adjusted in the dark so that the rounded end dips well into the water in the flat dish, which should be about one-half inch in depth. Adjust the flame to a height of one inch; this is accomplished by having the flame appear one-eighth inch above the metal chimney.

By means of the pinch-cock admit the solution until the point of light from the candle flame just disappears; that is, until the last point of light from the flame is no longer visible.

Remove the tube and read in millimeters the depth of the liquid. By means of the curve shown herein, the milligrams of sulphur in the 100 c.c. of solution is determined. If 25 c.c. were taken from 250 c.c. before the light is observed and this later contained the fusion from $\frac{1}{2}$ gram of coal, then the sulphur reading would be the weight present in $\frac{1}{20}$ gram of coal.

If, for example, the result shows 90 mm. in the tube there would be indicated 2.24 mg. of sulphur present in the quantity taken; that is 0.00224 gram. If one-half gram of coal is represented in this amount, there would be 0.0448 gram of sulphur, or 4.48 per cent., in the coal.

Special care should be taken to prevent the settling of the precipitate. A reading should be taken quickly and the contents poured back into the dropping funnel. Readings should be repeated several times to afford greater accuracy in the final average.

This method of making coal analyses has been used by the writer for some time with success. During a part of the time a woman who was employed in clerical work at the plant was used to make the analyses. The results given have been found to correspond closely with "check" tests made in independent laboratories.

Regulating the Frequency of Power Systems

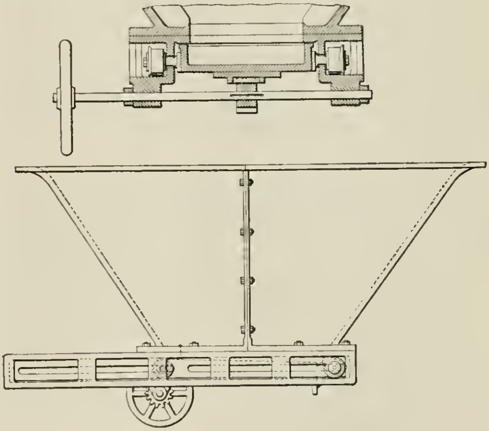
By R. A. Phillips

In large electrical systems consisting of several generating stations operating in parallel, it has been found best to make only one station regulate the frequency and to run all the other stations each at a definite load figure. The station regulating for frequency then takes whatever load changes occur, until the other stations can be made to increase or diminish their loads. It has been found that when all the stations in the parallel system undertake to regulate the frequency, great load transfers continually take place owing to the inaccuracies of the meters in the different stations and to the different ideas of the operators as to what loads their stations should carry.

The system operator makes up a load schedule for the entire day and apportions definite amounts of load for the different stations to carry; and the station with the largest number of units—which by their large number are usually of comparatively small size—is charged with taking whatever load swings are necessary to maintain constant frequency. Of course, over the valleys in the load curve at noon and in the evening, and at the times of day when the load increases or drops considerably, all the stations must change their load; and this figure is also worked out by the system operator.

Arrow Ashpit Gate

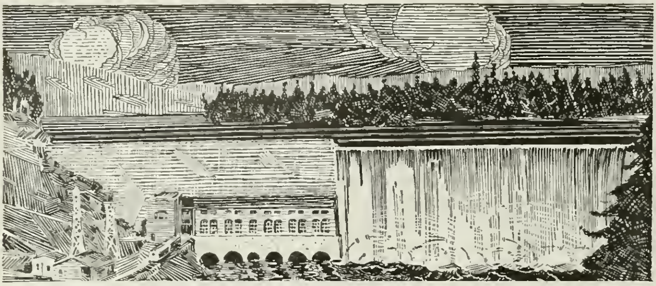
In large steam plants where stokers are used, it is common practice to discharge the ashes from the stoker into a hopper, thence by gravity into a larry car, from which they are discharged into a general ashbin, usually located over the railroad tracks convient for loading into cars. In very large plants a bottom-dump hopper beneath the stoker discharges directly into railroad cars, and with this system it is necessary to have a gate or valve to control the discharge of the ashes and to keep the openings tight when not in use. Recognizing that there is a field for an efficient ash-hopper gate, the Baker-Dunbar-Allen Co., Pittsburgh, Penn., has developed a single and a twin gate known as the "Arrow," which is capable of taking care of practically any conditions that may arise.



DETAILS OF ASHPIT GATE

The gate is made of heavy cast-iron sections, having cast-iron rollers. Being practically of cast iron in its entirety, it will stand up against sulphurous water, which is always present in hot ashes when water is used for quenching. As the gate operates on lubricated bearings, it is easily opened and closed. It will take care of any size opening necessary, being made for openings from 18 in. square to 3 x 5 ft.; that is, the bottom openings in the hopper can be made larger than the opening in the dump plate. Therefore, any clinker that passes a dump plate will pass through the hopper.

The gate closes against machined metal surfaces, which will remain tight as they automatically compensate for wear. It is lined with brick. It may be hand-, motor- or piston-operated with air, water or steam.



POP'S WATER-POWER COURSE

By

John S. Carpenter

POP stirred vigorously his third cup of the Greasy Spoon Beanery's standard brand of coffee, drained it, clinked the spoon down on the saucer and sat back studying Jimmy, who still struggled with a rubber tenderloin and wondered if death by starvation is painful.

"Jimmy," said Pop, "seein' as how I got three gages of this high-tension coffee in me, git Annie to give us a dozen of them catalogs called menus, an' I'll git to sketchin'."

Pop might just as well have spoken direct to Annie, the beautiful hussy with the granulated-sugar eyes, for she appeared presently with "them catalogs" and added the cheering remark, mainly addressed to Jimmy, that if she got fired for swiping the menus he'd have to support her for life, seeing that the Greasy Spoon was the only place in town that paid, counting tips, more than $35 a week.

Jimmy handed back the rubber heel, alias tenderloin, and told Annie that he preferred a peaceful end by starvation rather than a violent death by dyspepsia. Then he called for cigars, sipped his coffee now and then, and settled down to watching Pop make sketches.

"How did you ever come to learn drawing, Pop? Was it a case of early piety and late hours?"

"I guess that some Y. M. C. A. perfesser seed me drawin' my pay and 'lowed that I had considerable talent at that and hastily decided that the only way to keep me from bein' a bartender or some other kind of a regular guy was to grab me by the neck and lure me to his den. But what I'm a-tryin' to draw here is another of them ideal turbines like I drawed the last time we was talkin'."

"Uhuh," observed Jimmy, chewing the end of a five-cent Longshoreman's Delight.

"You see," assured Pop as he sat up from his painful efforts at drawing, "when you figgers a turbine, you goes at it from the tail end of the mule and works back. Now git out your pencil and figger. We'll say that in the case of our ideal turbine, we want 500 hp. and that we has 200 ft. head to drive it with. Now I figger, at 88 per cent. efficiency, 500 times 10, divided by 200, that's 25 cu.ft. of water per second that we gotta handle. Now," Pop pointed to the sketch, "we begin at the place marked 'curb ring' and we'll say that the velocity of the water at that point is that due to 6 per cent. of the head. So 6 per cent. of 200 is 12 ft. an' the spoutin' velocity for 12 ft. head is 28 ft. per sec., which I showed you how to find long ago. The area at that point is 25 divided by 28, or 0.89 sq.ft. In that table you got in that book, it says a circle 12½ in. in diameter is just a shade less than 0.89 sq.ft. in area, but it's close enough. From the conditions we hev given, a good designer would tell you that the runner would need to be about 22 in. in diameter to get a good shape of vane."

"Sposin' they made it less, then what?"

"Them vanes would be too short in the direction of flow—bent too sharp."

"So then the diameter of the runner isn't fixed by some hard and fast rule, but is a matter of judgment according to conditions?"

"Yep, it's a good deal like that. When we gits to studyin' other shapes of runners, you'll see that every rule has exceptions, as the guy says. Now, them gates is made so high that they has about the same velocity radial at the runner entrance as they is at the curb ring. When we comes to high-speed runners, you'll find that the radial velocity is purty high compared to the head. This entrance velocity at the runner inlet helps fix the angles that the runner vanes is bent to. That comes up in the velocity diagrams."

"It looks to me," observed Jimmy somewhat scornfully, "that with a little judgment and experience you could forget that there ever were such things as velocity diagrams or runner angles.

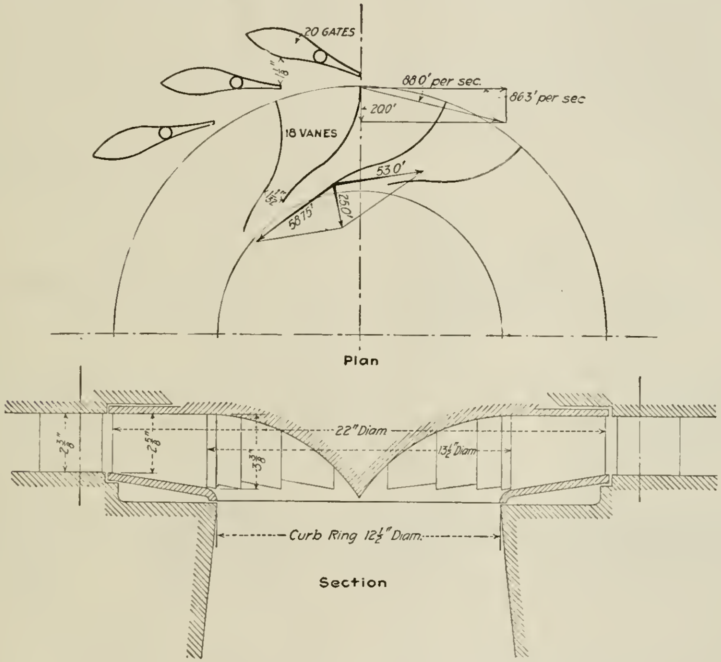
"Well," returned Pop thoughtfully, "a good many of the old fellers who made some of the standard turbines think so too. Our lecturer told me, confidential-like, as man to man, that some of them old fellers that's been at the turbine game for the last forty years or so couldn't tell you if velocity diagrams is a new 'flu' cure or if you play it on a pool table." Pop gave Annie the high sign for cigars.

"But so far we haven't said how many guide vanes, gates or runner vanes we're to have," Jimmy pointed out.

"We don't have to consider them yet. What you should have told me is that we ain't settled on the speed in r.p.m. of our turbine. Well, s'pose we make it 900 r.p.m., which is a good synchronous speed for 60-cycle juice. Seein' as how you agree to that, we'll now go ahead an' make the velocity diagrams. First, we'll figger the height or width of the runner. I said the velocity at that point should be about the same as in the curb ring. Divide 25 cu.ft. by 28 ft. velocity, which gives us 0.89, the area in square feet there. Multiply that by 144 to get square inches and divide by the circumference of the runner, the answer bein' 1.86 in. This is really too narrow for the runner width, as it's likely to clog up. In such a case we got to be guided by common sense, which is the least common of the senses, and try a lower velocity. Let's try 20 ft. velocity there and figger it over on that basis. Now we gits an answer of 2⅜ in.—a hull lot better. Now rememberin' that this velocity is at right angles to the circumference, we draws it that way, to some convenient scale.

"Next, the runner is 22 in. in diameter, and runs at 900 r.p.m., or 15 turns per second. The runner circumference is 3.1416 × 22 = 69 in., or 5.75 ft., and 15 times this gives us 86.3 ft. per second for the peripheral velocity. Drawin' that in as shown, to the same convenient scale, we gits a parrylelogram when we completes the sides, and the diagonal gives us the direction of the beginnin' of the vane, the angle of the wicket gates and the velocity through the gates. Then, as soon as we say how many gates we wants and draws in some, the velocity diagram gives us the gate openin'.

"If we chooses too few gates, they'll be as long as between paydays; if we use too many, they'll be as short as a pocketbook after squarin' up a man's size grocery bill. Most builders have standards to which they sticks, lackin' better judgment and because somebody else got by with it before like that. So 20 gates looks about right, which we'll prove when they is drawed in. You sees that I showed 'em with a curve on both sides of the gates. Well, some people makes 'em like that and some makes 'em with straight sides, dependin' on which boss in the shop can holler the loudest and say, 'I wants them gates this way.' and bein' that they's no law agin' it, the fat guy gits his way on account of weight of opinion."



SKETCHES SHOWING DIMENSIONS AND RELATIVE VELOCITIES

"How do you know, Pop, that the gate opening is correct, now that you've got it?" asked Jimmy, glad to get a word in, sardine style.

"I can prove it in a minute," responded Pop cheerfully.

"Say," Annie broke in, "are youse gentlemen gonna camp here?"

"Fergit it, fair one. We're busy talkin' over the election prospects in Grass Lake, Mich.," replied Pop tactfully, though somewhat ruffled.

"Now continuin'," said Pop to the spellbound Jimmy, "twenty gates times 2⅜ in. times 1⅛ in. divided by 144 gives what?"

"Just 0.37 square feet."

"Now multiply that by the velocity, 88 feet."

"The answer is 32.6 cu.ft. per sec. You got too much water, Pop."

"That's jes' what I'm a-comin' to. Thet 1⅛ in. is the most them gates should ever open to. That gives about 30 per cent. more water than 25 cu.ft. per sec., which is what we need for the turbine's normal load. When that turbine is connected to a generator, you'll find that for two, three or four hours, as the case may be, it's allowable to run the generator overloaded, and to git that you first got to have it in the turbine. For normal load the gate-openin' would be about ⅞ in., but as a fact, you couldn't git 30 per cent. overload out of the turbine, because both the turbine and the generator efficiency drops off at overload. All you'd prob'ly git is 25 per cent. more power."

Jimmy mumbled something to himself and then got the pencil going like mad. He was sure that he "had something" on Pop.

"Say, Pop, you got the overload at the gates all right, but not at the runner discharge. As near as I can figure, you have enough area at the ends of the runner vanes to get just 25.5 cu.ft. How in the Samhill can that pass 32.6 cubic feet?"

"This way," answered Pop. "When you opens them gates more than normal, you lets in more water, 'cause them gates acts sorter like the throttle on a steam engine, more or less, and that forces more water through the turbine because of the greater pressure in the runner, and increasin' that velocity of 58.75 ft. per sec. to whatever may correspond to the larger gate opening. See?"

"Hey, Annie," called Jimmy, with a dollar's worth of salve on every word, "the cigars are on me. Bring my favorite brand"—which was the only way that Jimmy could ever work off a "three-fer" on Pop.

"Tell me this, Pop. Why is it that the runner is made 2⅝ in. wide when the gates are only 2⅜ inches?"

"They gives the runner a little clearance so that they can be sure that the water gits in without buttin' up agin a square, sharp edge, as might be the case if the runner got outa line with the gate space."

"I think I understand the thing fairly well, Pop, so let's go on."

"I will if I ever recover from this thing you jes' handed me. I bet it's got an asbestos wrapper an' excelsior filler!" ejaculated Pop, throwing it with force into a handy "garbie." He gave Annie, who grinned from ear to ear, a wicked look, and turned to Jimmy. "The next time you wanna show yer frien'ship, jes' gimme a drink of barbed wire!" Then, in a more forgiving tone he said: "Now, they's some important points to git in this lesson today. The first is, that to git a certain power you need a certain size runner discharge, and to git a certain speed you need a certain runner diameter. Now suppose that you have to stick to a fixed, limited peripheral speed and that you want to increase the speed in r.p.m. That calls for a smaller runner until you find it darn hard to git in the size discharge you want and still keep the runner small to git high speed. It's like eatin' your pie and keepin' it. You can only go so far with keepin' the power and havin' high speed. That's the problem that's botherin' the turbine builders today. They all wants high speed in r.p.m. and high power. Now next time we'll see how they go about to git it, how they has to bulge the runner out so that its own mother would never recognize it, how they has to open the gates a hull lot more, and why they use what they calls a 'type characteristic,' which is another reason that chemical blondes marry plumbers."

Domes, Manholes and Steam Nozzles

BY W. H. WAKEMAN

Certain developments in steam-boiler construction as observed by an engineer who has seen long service in the operating field.

THE first tubular boiler of which the writer had charge was fitted with a large steam dome. A separate steam connection for an injector was wanted; so a ratchet drill was rigged up and operations were begun. It took a long time to drill the hole because the cast-iron head, shown in Fig. 1, was 1¾ in. thick. As it was necessary to have a manhole in the head (there being no other way to enter the top of the shell) as well as a steam nozzle, the head was a very weak form of construction. A large hole was cut in the shell and was left with rough edges and without reinforcement of any kind, thus producing another weak spot. Such a boiler would be allowed to carry only a light pressure at the present day. but this one carried 80 lb. for many years, until the mill was burned.

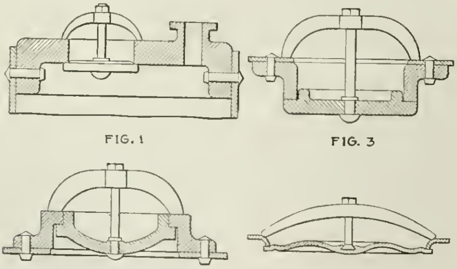


FIG. 1 FIG. 3 FIG. 2 FIG. 4

FIGS. 1 TO 4. METHODS OF STRENGTHENING OPENINGS IN BOILERS

The next improvement noted along this line is shown in Fig. 2. It consists of a separate opening into the upper part of the shell, reinforced by a heavy cast-iron ring riveted on the outside of the shell. It is much safer and more convenient. Another improvement is illustrated in Fig. 3, in which the ring is located inside of the shell; hence, when pressure is applied, it forces the ring against the shell, and danger of leakage is greatly reduced.

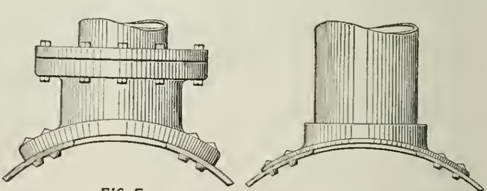


FIG. 5 FIG. 6

FIGS. 5 AND 6. STEAM NOZZLES FOR STEAM BOILERS

Still more modern practice consists in turning the edge of the shell inward and milling the surface to receive a gasket, as shown in Fig. 4. Experiments have demonstrated that this form of construction is at least strong enough for all useful purposes, and it is much better than adding an extra ring, although no material is added to the original plate. It demonstrates that the form given to the material used is a factor in the case, as well as the thickness.

The separate manhole requires another fixture for the steam outlet, and one of the earlier forms is shown in Fig. 5. It consists of a cast-iron nozzle riveted to the outside of the shell. The upper part forms a standard flange, to which is bolted another flange which carries the steam pipe. As the surfaces are not ground to a perfect fit, packing must be used in the joint. When the packing must be renewed the boiler has to be laid off, as there can be no valve below this part by which the steam could be shut off. To overcome this objection and dispense with the use of cast iron the construction shown in Fig. 6 is employed. A steel saddle is riveted to the outside of the shell, and the upper part is turned and tapped to receive the steam pipe. It is lighter and stronger than cast iron and the appearance is satisfactory.

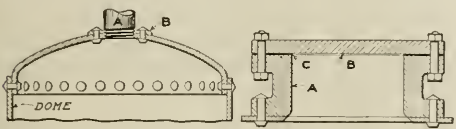


FIG. 7 FIG. 8

FIGS. 7 AND 8. REINFORCED OPENING IN DOME AND CONSTRUCTION OF CAST-IRON MANHOLE

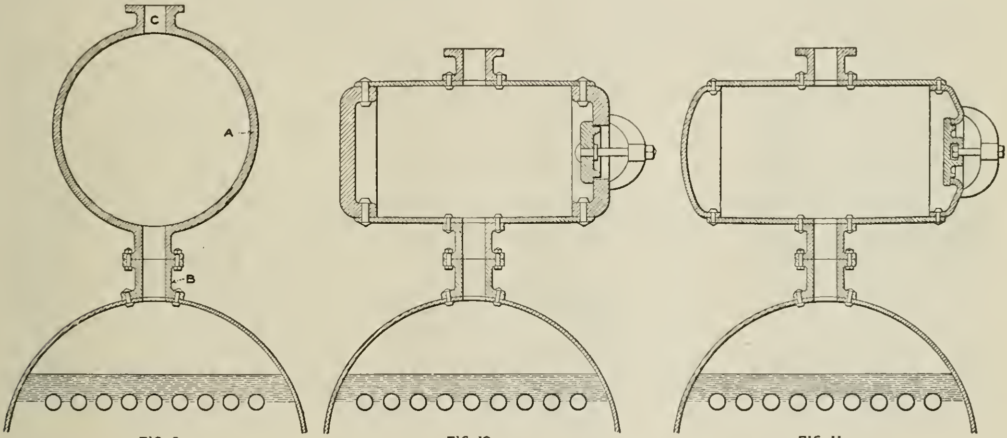


FIG. 9 FIG. 10 FIG. 11

FIGS. 9 TO 11. VARIOUS FORMS OF SO-CALLED STEAM DOMES FORMERLY USED

Where a dome is used at all on a steam boiler, it should be fitted with a convex steel head, as shown in Fig. 7. The steam pipe *A* is screwed into the top of the dome, but a reinforcing ring *B* is required to provide the thickness necessary to insure a good hold for the pipe threads.

The worst form of manhole and cover that the writer ever used is shown in Fig. 8. On the outside of the shell is riveted a cast-iron ring *A* to the top of which is bolted a flat, oval cast-iron cover *B*. The surfaces were rough and so a thick gasket *C* was used. The nuts were screwed down as far as possible when the packing was put in, making a tight joint at first; but after heat was applied, the packing would shrink, leaving it comparatively loose. It was not safe to tighten the nuts when steam was on the boiler, because when one was drawn up, it took more than its share of the stress and there was danger of stripping the threads or breaking the bolts. The failure of one bolt would endanger others in the joint and the whole might fail. The only safe way was to remove all steam pressure from the boiler, which was very inconvenient.

Certain boilers were built by a man who believed in the use of what he called a dome, illustrated in Fig. 9. It was a hollow cast-iron sphere *A* bolted to a cast-iron steam nozzle *B*. The steam pipe was bolted to the top at *C*, thus making two packed joints. Considered as a dome it is worse than useless and as a reservoir for steam it is only a little better, for two reasons: It is not large enough to hold sufficient steam to be serviceable and it is located near the boiler when it ought to be close to the engine. No kind of dome is of value as constituting a reservoir for steam. To be of any use the opening below it into the shell should be nearly full size. If it is small, as shown in Fig. 9, the velocity of the incoming steam equals that of the outgoing and there is a slight tendency to reduce pressure at this point. If it is reduced even one-half pound when there is a heavy demand for steam, water from the surface that is directly under the opening will be forced upward, causing wet steam to pass out of the dome. The water cannot fall back into the boiler because the velocity of the outgoing steam is too great. On the other hand, if the opening through the shell is ten times the area of the steam pipe, the rising steam will flow slowly. Not only does this prevent priming, but any water coming into the dome can fall back into the boiler. The objection to the dome is that it weakens the shell.

Other boilermakers have made these so-called domes larger, as shown in Fig. 10, but the principal result is more joints to be taken care of, without corresponding benefit. If domes are fitted with cast-iron heads, as shown, they are heavy and dangerous when used for high pressures, although the first cost is less than for convex steel heads, shown in Fig. 11. The latter are safe under any pressure that can be allowed on the shell, but in either case the device in the opinion of the writer is not of enough value to balance the first cost and pay for the room that it occupies.

A new hydro-electric plant will be erected in Taiwan, Formosa, under Government auspices. The company is capitalized at $15,000,000.

The Electrical Study Course—Two-Phase Systems

Hydraulic analogies are given of a two-phase alternating-current system, and then the discussion is continued to show how a two-phase system may be obtained from two single-phase generators or from one generator having either one or two windings on the armature.

TWO or more alternating voltages can be combined to provide what is known as polyphase systems; that is, systems in which more than one voltage is present. This is somewhat analogous to direct-current practice in which we may have a two-wire system supplied from a single source of voltage, or a three-wire one in which are combined several sources of voltage. In alternating-current practice the single-source system is referred to as a single-phase one, and the systems having more than one source as polyphase systems. There are two polyphase systems in general use: they are the two-phase system and the three-phase system.

The single-phase system we are already familiar with: for instance, either generator 1 or generator 2 in Fig. 6 would be a single-phase generator, and the wires leading from it would constitute a single-phase system.

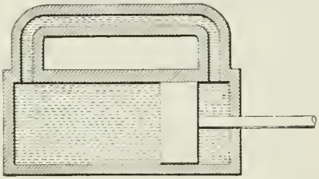


FIG. 1

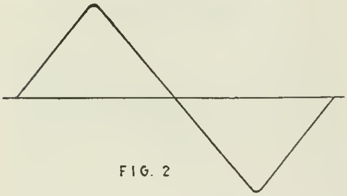
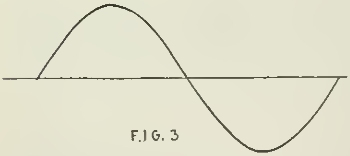


FIG. 2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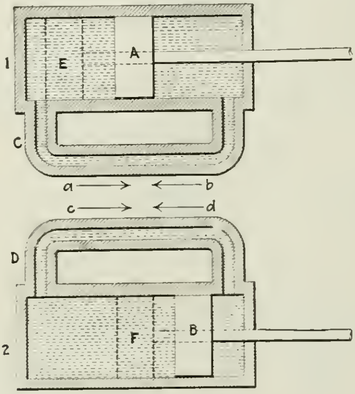


FIG. 4

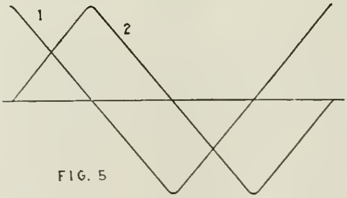


FIG. 5

FIGS. 1 TO 5. HYDRAULIC ANALOGIES OF SINGLE-PHASE AND TWO-PHASE SYSTEMS

The relations in the two-phase system may be illustrated by means of a hydraulic analogy. From another lesson we know that if the piston in a cylinder, such as that shown in Fig. 1, is moved back and forth in such a manner that the pressure increases gradually from zero at the beginning of the stroke to a maximum at the middle, and then again decreases to zero by the time the piston has reached the end of its travel, the variations in pressure for a complete forward and return stroke may be illustrated by some such curve as that shown in Fig. 2. If for the water pump we substitute an electric pump, for example the alternator No. 1 of Fig. 6, then its electrical pressure or voltage could be represented by a sine curve such as that illustrated in Fig. 3.

Suppose, now that we have two water pumps as shown in Fig. 4, and that they operate in unison, but that the piston *A* of cylinder 1 is set one-half a stroke ahead of piston *B* of cylinder 2. Water will be flowing at maximum speed through pipe *C*, in the direction of the arrows *a*, while there is no flow of water in pipe *D*. After a half stroke *A* will be in the dotted position *E*, and *B* in the dotted position *F*. The flow of water in *C* will have ceased, whereas that in *D* will be at a maximum in the direction of the arrow *c*. After another half-stroke, the flow in *C* will again be at its greatest value, but in the direction of the arrow *b*, and that in *D* will be zero. After still another half-stroke the flow in *C* will have ceased and that in *D* will be in the direction of the arrow *d*. The pressure in each cylinder can be represented by a curve, as in Fig. 2, but when the pressure in one is greatest that in the other is zero, and vice versa. This relation would be indicated by placing the curves in the positions shown in Fig. 5, in which curve 1 applies to cylinder 1 and curve 2 to cylinder 2.

In place of the two water cylinders let us use two alternators, such as those in Fig. 6. They are alike in all respects and are coupled together, but before coupling, the armature of one has been given a quarter-turn so that the taps *ab* on the winding of No. 1 are 90 deg. ahead of those on the winding of No. 2. Then the relations between the voltages will be the same as those between the pressures in the cylinders of Fig. 4. When the voltage of generator 1 is a maximum, that of 2 will be zero, and vice versa. The relation existing would therefore be expressed by two sine curves, each similar to the curve of Fig. 3 but spaced as shown in Fig. 7, in which E_1 represents the voltage of alternator No. 1 and E_2 that of alternator No. 2.

The two machines combined would be a source of two-phase voltage, and the four wires from them would constitute a two-phase system, of which the wires *AB* would be one phase and the wires *CD* the other phase. In general, a two-phase system is one supplied from two sources of alternating voltage, of the same frequency and of the same voltage, but with a phase difference of 90 deg. between them.

When there is no electrical connection between the machines, a voltmeter connected from a wire of one phase to either wire of the other will give no indications. If, however, a wire of generator 1 were to be connected to a wire of generator 2, as for example *B* to *C*, as indicated in Fig. 8, there would be an addition of voltages, since the voltage across *AD* would be equal to the sum of E_1 and E_2, and hence equal to the sum of the sine curves, as represented by curve *E* in Fig. 7. The maximum height of this curve is equal to 1.414 times the maximum heights of E_1 or E_2. Thus if V_1 and V_2 read 100 volts, *V* would read $1.414 \times 100 = 141.4$ volts. If a single wire *F* be run from the junction of *B* and *C*, we have a modified form of two-phase system called a three-wire two-phase system.

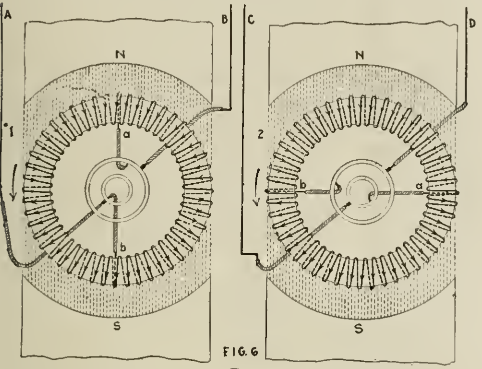


FIG. 6

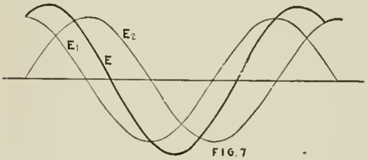


FIG. 7

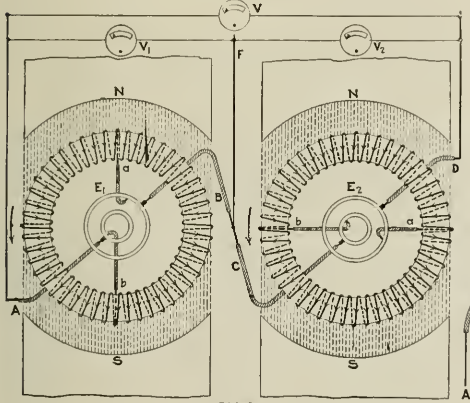


FIG. 8

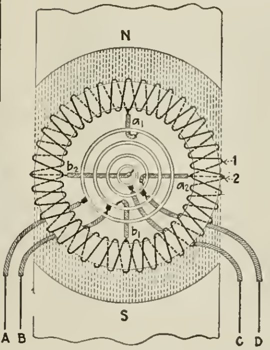


FIG. 9

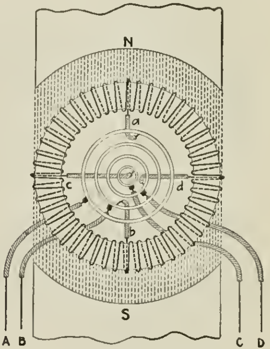


FIG. 10

FIGS. 6 TO 10. COMBINATIONS OF GENERATORS AND WINDING FOR PRODUCING A TWO-PHASE SYSTEM

Instead of using two generators coupled together to furnish two-phase service, a single generator with two armature windings may be used, and in fact that is the method employed in practice. Thus, in Fig. 9, we have a single armature upon which are two windings, 1 and 2. The taps a_1b_1 of winding 1 are taken at right angles to the taps a_2b_2 of winding 2, as shown. Therefore the conditions governing the generation of voltage will be precisely the same as if we had the two windings on separate armatures as in Fig. 6. That is, the voltage across a_1b_1 will be at a maximum when that across a_2b_2 is zero, and vice versa. The machine is provided with four slip rings and one of the taps is connected to each. In Fig. 9 the connections are so made that winding 1 connects to the wires *AB* and winding 2 to the wires *CD*, and these two sets of wires therefore comprise a four-wire two-phase system that differs in no respect from the one illustrated in Fig. 6, and they would likewise form a three-wire two-phase system if *B* and *C* were joined.

Another method of obtaining two-phase service from one armature is to use a single winding and tap it at four points, as shown in Fig. 10. The two phases would be *AB* and *CD* respectively. This method could not, however, be used for a three-wire two-phase system, since connecting *B* to *C*, for example, would be the same as connecting *b* to *c*, which would result in a short-circuit of the part of the winding between those two taps.

The first problem of the preceding lesson was to construct the vector diagram for the sum of two voltages, 100 and 150 volts, that are 120 deg. apart. The two voltages are represented by the vectors E_1 and E_2 in Fig. 11. To find their sum we add E_2 to E_1 as shown by *ab*. The vector *E*, drawn from *O* to *b*, is therefore the sum required. Careful scaling would show its value to be 132 volts.

The second problem was to find the value of the sum of two such voltages as the foregoing if they were each equal to 100 volts. The two voltages in that case would be represented as in Fig 12. To add E_2 to E_1 we draw *ab*. It will be found that the sum *E*, found by joining *O* and *b*, is the same as E_1 or E_2: namely, 100 volts.

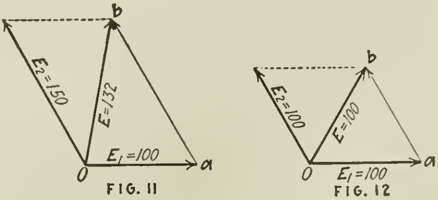


FIG. 11 FIG. 12

FIGS. 11 AND 12. ADDITION OF TWO VOLTAGES 120 DEG. APART

The Functioning of the Chain-Grate Stoker

By T. A. Marsh
Chief Engineer, Green Engineering Co., East Chicago, Ind.

The functions of the chain grate, depth of the fuel bed and grate travel, igniting arches, advantages of the waterback, elimination of air leakage, cleaning the air space, and an analysis showing why the ash is always at the bottom of the fuel bed.

Established as is the use of the chain-grate stoker, there still exist many vague notions concerning the actual functions of the chain grate and its accessories, the igniting arch, the waterback and other elements of furnace construction. The chain grate burns coal progressively. The green fuel enters the furnace at one end, passes through the various stages of combustion, and the ash is discharged from the furnace at the other end. To be automatic a stoker must feed coal into the furnace, carry it through the various stages of combustion, discharge the ash and refuse and keep the grate surface clean and ready for a continuation of the process.

All stokers may be divided broadly into two classes—those with traveling grate surfaces carrying the fuel through the furnace in a positive manner and those with stationary grate surfaces over which the fuel is advanced by some type of mechanism or by gravity. Chain grates come under the first broad classification, the layer of fuel of definite depth being carried into and through the furnace.

The Amount of Fuel That Is Fed

Two factors determine the amount of fuel fed—depth of fuel bed and the speed of grate travel. The depth of fuel bed is regulated by the fuel gate, which is a simple mechanism and should be easy to operate. Gates must be raised and lowered readily, otherwise operators will not regulate the fires with proper frequency, resulting in operation under improper conditions adverse to the best economy. Fuel gates are exposed on one side to furnace temperatures and therefore should be well protected by firebrick and tile linings, which are the most satisfactory for this purpose.

Grate travel is controlled by the speed of the stoker-driving engine or motor and the individual driving mechanism of each stoker. The engine or motor speed regulates all furnaces simultaneously to meet increasing or decreasing steam demands, but the individual operating mechanism of each stoker is used to regulate the individual furnace to insure the best conditions for efficient operation.

In general the expression "thin fires for capacity and thick fires for economy" is true, but it must be considered only relatively. Some fuels, such as lignites, give better results with thin fires. Coarse coal demands thick fires. Low draft prevents thick fires. Fuel beds from 4 to 10 in. thick are usual practice. Chain speeds vary up to 12 in. per minute, although many furnaces are so designed as to permit speeds of only 4 in. per minute. The higher speeds, say 6 to 12 in. per minute, are within limits of modern practice and are being obtained in everyday operation.

Discussion of chain speeds leads at once to the rate of ignition. Early chain-grate installations reached their limitation in the amount of coal that could be ignited. Short arches 3 to 5 ft. long, sprung arches, low-set arches and a number of other faults were responsible. The correct location, slope and length of the igniting arch are all important. Untold harm has been done by experimenters attempting to design and install arches in the absence of full knowledge of the stoker, furnace, coal draft, and in fact all elements entering into the ignition and combustion problems. The arch is a study for a furnace designer and should be so treated if proper results are to be obtained.

The function of the arch is to ignite the fuel, and the variables to be considered are: Combustion rate, percentage of volatile combustible in the fuel, calorific value of the fuel and the stoker length. Obviously, the higher the combustion rate desired the greater must be the provision for igniting the fuel. There are always two items, either one of which may limit the capacity—ability to ignite the coal and draft to burn it when once ignited. Therefore, since igniting ability increases directly with arch lengths, all other items remaining constant, longer arches must be provided for high combustion rates.

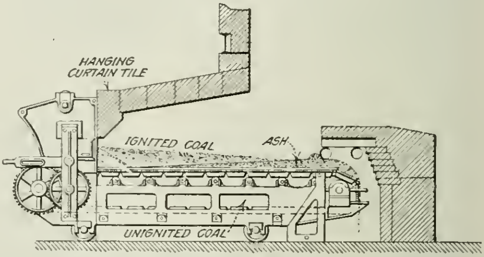


FIG. 1. ONE TYPE OF LONG FLAT ARCH, ALSO PROGRESS OF COMBUSTION ON CHAIN GRATE

As the percentage of volatile combustible decreases, extra provision must be made to ignite the fuel. Fuel containing as low as 12 per cent. of volatile has been handled successfully on chain grates, but the problem of furnace design becomes highly special with such fuels. The higher the calorific value of the fuel the higher the furnace temperatures and the more intense the ignition becomes.

For many years arches were rather promiscuously applied in furnaces, and frequently stokers 11 and 12 ft. long were equipped with arches no longer than those provided for stokers 9 or 10 ft. long. Naturally, there was insufficient ignition to keep the grates properly covered, and in consequence long stokers fell into disrepute, many engineers contending that a length of 10 ft. was close to the limit. Recent practice, however, of making arches proportionately longer as the stoker length is increased, has rendered the grate area of long stokers just as effective as that in the shorter ones and has resulted in higher capacities from the larger units.

Ignition arches should be designed for their ability to ignite coal at certain rates per hour. The ignition rate is independent of the grate length, but to obtain similar combustion rates on longer stokers, the arches must be designed proportionately longer. Today, stokers 13 ft. long are producing high capacities, experiments indicate that 15 ft. is not beyond the limit in length, and there is no doubt that the demand for higher capacities will produce furnaces with chain grates in excess of 15 feet.

When arch lengths are to be determined, furnace designers take into consideration the four variables that have been under discussion. There is, of course, some latitude as bridge-walls of various designs and the type of arch employed have a marked effect. As an illustration Fig. 1 shows a flat arch that provides uniform height above the fuel bed from side to side of the furnace and uniform delivery of the gases to the boiler. It is unusually long. A hanging curtain tile at the front causes such air leakage as occurs between the front arch tile and the stoker gate to enter the furnace 12 in. or more below the lower surface of the arch. With the earlier constructions such air leakage chilled the front arch tile. In the arch illustrated this air not only does not retard ignition, but some of it doubtless enters into combustion and increases the furnace temperature. Arches can and are being installed to ignite 40 to 50 and even 60 lb. of coal per square foot of grate area per hour. With the present knowledge of furnace design, the ability to ignite the fuel should not be the limiting factor as regards capacity. No general rule can be given for arch locations for all boilers, coals, drafts and combustion rates. It should be realized that this is a problem by itself, involving also furnace volume, type of boiler, heat absorption, furnace maintenance and smokelessness.

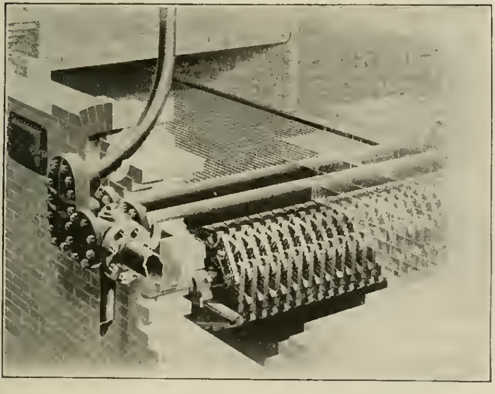


FIG. 2. A TWO-PIPE PRESSURE WATERBACK

LARGE FURNACE VOLUMES

As fuel enters the furnace, the heat liberates the hydrocarbons or volatile constituents, which ignite and burn. The heat of this combustion is delivered to the boiler. Volatilization, ignition and combustion of the hydrocarbons occur almost simultaneously. In fact, when the time element is considered, the process seems more in the nature of an explosion, due to the rapidity with which it occurs.

In addition to long and suitably designed ignition arches, large furnace volumes are required for combustion, particularly of fuels high in volatile content. Few furnaces, in fact, have been designed sufficiently ample to completely accomplish this combustion process in the furnace itself. The necessity for large furnaces is being realized, and there should be much progress along these lines within the next few years.

COMBUSTION OF THE FIXED CARBON

Theoretically, combustion of the fixed carbon in the fuel should not occur until all the volatiles have been distilled off. Practically there is no doubt that some combustion of fixed carbon occurs from the instant the fuel enters the furnace. It is evident, however, that combustion of the fixed carbon cannot become active until all volatiles have been distilled, so that the more rapid the volatilization, the sooner the active combustion of the fixed carbon can begin, and the more thorough will be the combustion by the time the fuel has reached the end of the grate.

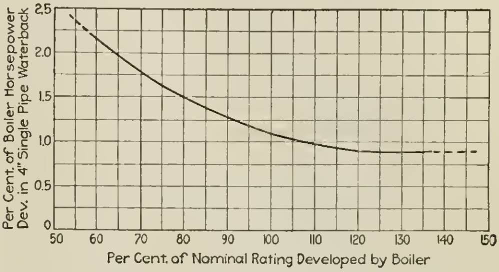


FIG. 3. PERCENTAGE OF BOILER HORSEPOWER DEVELOPED BY SINGLE-PIPE WATERBACK

The fixed carbon or the solid portion of the fuel is ignited under the arch and continues its combustion until burned out at the end of the grate. Naturally, as this fuel burns, the fuel bed tends to become rarer and in earlier installations permitted excess air to pass through the rear section of the grate. In plants of old design this was a source of loss, and even at this time it is not unusual to find engineers referring to the rare fuel bed at the rear of the chain grate as an inherent fault in this type of stoker. Such statements simply exhibit a lack of knowledge of the subject for in modern installations with properly set waterbacks, the fuel bed is more compact at the rear than at the front.

THE WATERBACK AND ITS FUNCTIONS

For this condition the waterback is responsible. Its functions are to compress the fuel bed, making the rear portion more dense than the front; to retain the upper or unburned portion of the fuel bed on the end of the stoker where the draft intensity is strongest, thus reducing carbon in the ash; to present a water-cooled surface to which clinker will not adhere, decreasing labor; to eliminate the burning off of bridge-walls, decreasing furnace maintenance.

Waterbacks at any height above the grate surface will accomplish the last two functions, but to accomplish the first two (and they are by far the most important) they must be set at a proper height above the fuel bed. To meet a variety of fuel, draft and load conditions, it is frequently necessary to vary this discharge opening. This requires a vertical adjustment of the grate surface. Stokers having provision for such adjustment are therefore at an advantage over those that cannot be adjusted vertically without tearing out the brickwork and making a permanent change.

The height of the waterback above the grate is governed by the thickness of the layer of ash on the grate at the rear. If the ash is 3 in. deep, the waterback should be set 3 in. above the grate. With this relationship the coke on top of the ash will be retained and the fuel bed will be compressed against the waterback. Above all things waterbacks must not be set so high above the fuel bed as to barely come in contact with it. The discharge opening must always be sealed with ash, and the fuel bed must be compressed if high efficiencies are to be obtained.

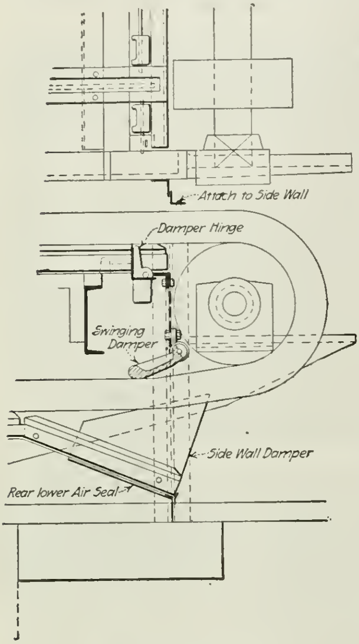


FIG. 4. REAR AIR SEAL

There are two types of waterback—plain and pressure. Their functions are identical, but plain waterbacks have circulation separate from that of the boiler, while pressure waterbacks (see Fig. 2) are connected to the boiler. The former type wastes the cooling water unless it can be used as feed water or in some plant process; the pressure type adds effective heating surface to the boiler. Fig. 3 gives an indication of the heat absorption in terms of boiler rating developed. The data were compiled by H. B. Dirks, mechanical engineer, from tests made at the University of Illinois. In the furnace under test and with a single-pipe waterback, the heat absorption varied from 1 to 2.5 per cent. of the total horsepower developed, an item not to be neglected in power-plant economy. Tests made by the Green Engineering Co., on a 752-hp. Stirling boiler with a double-pipe waterback, operating at ratings of from 130 to 225 per cent. of normal, indicated that the heat absorption varied from 2.5 to 3.5 per cent. of the total heat generated. Every engineer knows that it is a layer of ash that is discharged from the rear of the chain grate, but not every one has considered how and where this ash layer was formed. Fig. 1 indicates the structure of the fuel bed throughout its progress in the furnace. Ignition is effected by the arch above the fuel bed and is therefore a downward action. When the fuel bed is ignited thoroughly, as it is in the first few inches of travel in a properly designed furnace, combustion of the solid fuel must be from the bottom, as the air supply is from the bottom. The layer of ash starts, therefore, on the bottom of the fuel bed and increases in thickness until the entire fuel bed has changed to a layer of ash at the rear of the stoker.

ELIMINATION OF AIR LEAKAGE

Applying to practically all stokers and to hand-fired grates the fundamental rule of economy is to "keep the grate uniformly covered." The purpose of keeping the grate covered is to prevent air leakage into the furnace. This presupposes that with the grate covered there will be no leakage of "unauthorized air" into the furnace. Such is not always the case with the chain-grate stoker, although the better and more modern installations are so constructed as to prevent air admission other than through the fuel bed. In one type of stoker leakage is eliminated as enumerated in the following:

Between the sides of the stoker chain and the furnace walls air leakage is prevented by means of tight ledge plates. Adjustable members are necessary for a seal between the brickwork and the moving chain. Permanently fixed pieces burn away, warp or settle, destroying the air seal. Adjustable and renewable parts make it possible to keep this seal in order.

Through the rear of the stoker between the chains tight baffles stop the air, and a substantial baffle is also placed underneath the stoker between the lower lead of chain and the floor. In addition there are side-wall dampers between the stoker side girders and the furnace walls. The ashpit should be tight. Fig. 4, shows the rear air seal and Fig. 5, the location of the ledge plates. The effectiveness of these air baffles is a measure of the efficiency of the chain grate under operating conditions.

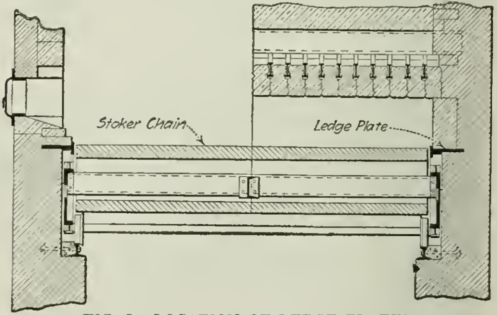


FIG. 5. LOCATION OF LEDGE PLATES

CLEANING THE AIR SPACE

Of the list of the four functions of an automatic stoker—feeding fuel, burning fuel, discharging ash and cleaning the air space—the first three have been discussed. The final feature of cleaning the air space is automatic with chain grates and easily accomplished. Staggering the links forming the grate surface causes a shearing action that frees the air spaces of accumulations of ash or refuse, leaving the grate clear and ready for a repetition of the process.

This study of the functioning of the chain grate should indicate the value of careful design in the grate itself, the arch, the waterback, the furnace and particularly the air seals. It should be evident that it is the refinements in the designs of these elements that are responsible for the high efficiencies now being obtained in chain-grate practice.

EDITORIALS

Power-Plant Accounts

IN THE keeping of power-plant accounts—and other accounts for that matter—depreciation is an item which makes the inexperienced all sorts of trouble and which in the hands of the experienced can be used to throw a balance to one side or the other.

Much of the confusion would be avoided if a clear understanding were had of what is meant by the term; whether for instance the purpose is to find the present worth of the plant or the average annual cost of running it over a term of years.

In making up the cost of producing an article or performing a service there must be included not only the cost of fuel, labor, oil, etc., but that of the engine, boiler and other plant equipment that is used up in the process.

If it could be known to start with how many kilowatt-hours or pairs of shoes or what-not the engine was going to turn out while it remained in the service, and how much its salvage value would be when it got through, it would be easy to tell how much money's worth of engine would be used up per unit of product. But this is not to be known in advance.

The cost does not need to be fixed, however, with such precision that it cannot be estimated and averaged. An engine will last with good treatment some twenty years. If to the other expenses of each year there are added five per cent. of the cost of the engine and this included in the selling price of the product; all of the money that was paid for the engine will be recollected from the users of the product by the time the engine is used up. The life of the engine might be taken at some other term than twenty years for some kinds of engine in some kinds of service, but the conception is the same. The engine is being used up year by year, and it is a question of making each year bear its average share of the total cost.

How much does it cost to wear a linen collar? One who thought no further than the laundry bill would say "three cents a wear." But a collar costs a quarter and will go say, ten times to the laundry. Then every time it is worn, two-and-a-half cents' worth of collar is used up. This is depreciation—used-up-ativeness—and handled in this way it is very simple, the only uncertainty being whether the collar will go ten times to the laundry or the engine will stay in the service under consideration the assumed number of years.

If an engine had to be sold at the end of a year's run it might not bring more than a half of what it had cost to buy it, set it up and pipe it ready to run. Not only would the engine be second-hand but all the costs of purchase, transportation, erection, piping, etc., would have been incurred for a single year's use of the outfit, and the things which the engine turned out—kilowatts, shoes, etc.—would cost an exorbitant amount of engine apiece.

But the engine is put in with the expectation that the business is going to continue, and if the probabilities were not strongly in favor of such continuation nobody would risk his money in it.

One might collect in the profits of the first year this remotely possible quick slump in the value of the engine to the business, and thereafter charge only such falling off in the value of the engine as actually occurred, which would be little if anything for a number of years.

On the other hand, another legitimate charge in making up the cost of a product is interest on investment. The cost of the engine is charged to the capital or investment account and interest upon this account is charged as a part of the cost of running the business. But when a portion of the capital so invested is recollected as a part of the selling price—that is, as depreciation—interest should no longer be charged upon it. The amount collected in depreciation should be credited to the capital account, and interest collected only on the unretired amount. Even if a business would stand the collection of profits which would retire half of the investment the first year, it would be simply withdrawing that sum from where it was earning a fair rate of interest, reducing the profit of the following years by the depreciation thus prematurely charged, and making it possible for the property, practically new, to be taken by condemnation at its depreciated value.

Perpetual Motion Wages

INDUSTRIAL unrest engages the attention of everyone these troublesome days, whether one be proletariat or a plutocrat, to use terms which economists have made familiar. Last week the power houses of the greatest electrical transportation system in the world were gasping on banked fires due to a strike, and these power houses are among the greatest in point of size and modern equipment. It was not a strike of power house crews, they merely went out when the nearly fifteen thousand employees struck. But they went out. And it is unusual for the power house crew of an establishment to strike when the other workers therein do.

Perhaps the participation in the strike by these crews presages nothing unusual. But the strike, as a whole, as one of many similar actions, is a symptom of deep-seated social unrest the end of which no man knoweth now. After tying up the metropolis for forty-eight hours the men were given practically all they asked for, and immediately the people rode to work instead of paying outrageous cab fares or walking. Everybody is happy—everybody but the stockholders of the company.

Everybody these days is out to profiteer, some in a small way others in a large way. The man in Wall Street who motors daily to his estate in Longshort Hills, the aproned commission merchant—even the peanut-stand man is doing it. And so one after another of the various classes of consumers as classes of labor, strike, get a raise and go on.

Now one does not have to be a student of John Stuart Mills or Professor Laughlin to see that carried to the extreme to which we are headed this perpetual motion wage-raising trend is suicidal. If the cream cheese workers are raised twenty-five per cent the dispensers of the product use it as an excuse to increase the price forty per cent. And so it goes. Warren Stone of the Locomotive Engineers uttered sound sense when he told the Congressional Committee that raising wages would do his men little good. Reduce the cost of living, he said. That is what we all want; but we never will get there by the route that is now so popular.

The Selection of Electric Motors

A motor to successfully meet the requirements of the drive to which it is applied must develop sufficient torque to start and accelerate its load within a reasonable time without being subjected to injurious conditions. It must also be of such a capacity as to drive its load without undue heating, and have speed characteristics suited to the load. Of the two evils in the selection of motors it is always better to have the motor too large than too small. Since in the former case the motor will be capable of doing its work, where in the latter if it is heavily overloaded it will be only a matter of time before the high operating temperatures will destroy its insulation, and it will have to be rewound. However, there is no real advantage in selecting a motor that is unduly large and expensive to do the work. It would be a useless increase in cost to install a direct-current motor designed for adjustable-speed service on a drive that is always to run at a constant speed, or a compound-wound motor where the starting requirements are light and the load fairly constant.

If motors are selected too large the initial investment is not only higher than what it should be, but a machine too large for the work it is doing will be operating at a lower efficiency than one of the correct size, consequently with the large unit the yearly cost for power will be higher. There always has been the question as to whether or not the maintenance charges are not lower on direct-current machines operating at twenty to twenty-five per cent. below their normal full-load rating, than when carrying full load. However, with motors properly designed for the load they are driving there is no reason why they should give any more trouble when operating at full load than at seventy-five per cent. full load. In any case where the machines are given proper care the additional cost of installation and yearly cost of power will offset any reduction in maintenance that might occur with the under-loaded motors. With underloaded induction motors the cost of installation is not only increased and the motors operated at a lower efficiency, but they also operate at a lower power factor; thus requiring larger generator and transformer capacity, and a more expensive transmission and distribution system, with accompanying poorer voltage regulation.

Before an intelligent selection of motors can be made it is necessary to know the characteristics of the load to be driven, the starting and accelerating torque required, whether the load is constant or variable, the maximum peaks that the motors will be required to take care of, etc. The horsepower requirement is one of the most important items but not always the determining factor in the size of the machine. When motors designed for a twenty-five per cent. overload for two hours are applied to loads that are intermittent or variable, it is frequently possible to take advantage of the motor's overload capacity to drive the load during the peaks without overheating, with a considerable saving in the initial cost of installation. It is only by a careful study of all the elements affecting the loading of the motor that the best one can be selected for a given drive. With the present high cost of motors and in many cases of power an intelligent study of motor requirements in industrial plants apparently holds forth an opportunity for engineers to bring about a considerable economy.

Experience begets confidence. When the first two five-thousand-kilowatt generators were installed, about twenty-five years ago, at Niagara Falls, the engineer in charge of operation—now one of America's best-known electrical engineers—was afraid to parallel them until a third machine had been installed to take care of the load in case paralleling two of the units proved disastrous. However, the operator made a mistake one day and by accident paralleled the two machines and nothing happened. Today units of capacities not dreamed of in those pioneer days of twenty-five years ago are paralleled with systems of two and three hundred thousand kilowatts, almost as easily and with as little concern as any other daily operation about the plant. It is all very easy when you are sure of what you are doing—this is experience.

For a number of years past it has been apparent that the largest-capacity electric-power station units would be steam-turbine driven machines. However, with three 45,000-kilowatt hydro-electric units on order and the 50,000-kilowatt unit water-turbine machine under consideration, it is apparent that the single-unit turbo-alternator may have to take second place in size with its white-coal competitor.

Bonuses won't thrive in a plant where leaks are permitted to thrive. Every pound of coal, every quart of oil and every other little thing wasted represent just so much profit on the business lost and so much less money available for wages. Ask the manager of any department of a corporation what the budget is and whether or not wages figure in it.

Now that the war is over fuel oil is again coming to the front, the peace time industrial front. If the coal market does not put both feet on the floor and stay put fuel oil will see to it that this solid fuel makes its exit from many plants not to return right away.

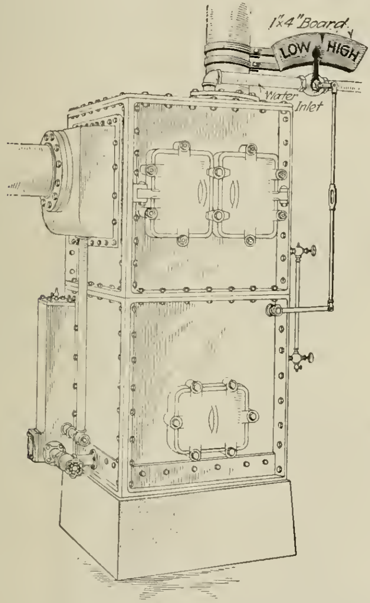
The difference between the good mechanic and the man who would like to be a good mechanic is the difference between actually doing something and merely wondering if it could be done.

We would remind those who predicted the utter failure of all the German ships hastily repaired by American engineers by welding that they are still in service.

· Correspondence ·

Heater Water-Level Indicator

We have an open heater in the engine room where I am employed as engineer. Water enters at the top through a quarter-turn valve operated by a lever and a rod connected to a float in the heater. The heater is in one corner of the engine room, and the glass gage being at the bottom, I could see the water in the glass from only one point. The float valve would stick sometimes, but I would not know whether it was stuck or not except by going to see and, of course, I made many unnecessary trips to watch the water and try to keep it at the proper level.



HIGH- AND LOW-WATER INDICATOR

I made an indicator from a piece of iron about 1½ in. wide by 12 in. long, cutting a square hole in one end to fit the end of the valve stem at the top of heater and shaping the other end as shown. I placed this pointer on the valve stem so that when the water was at the proper level it would stand plumb. I also made a board fast to the heater and marked it where the pointer should be. This pointer is moved back and forth by the float as the water level in the heater changes. If the heater becomes dry, or nearly so, the pointer will indicate it by pointing to one side, marked "Low" on the board, and when the water gets high it will point to the high side.

From any part of the engine room I can now see where the water level is and it has saved me considerable walking. J. R. WEBB.

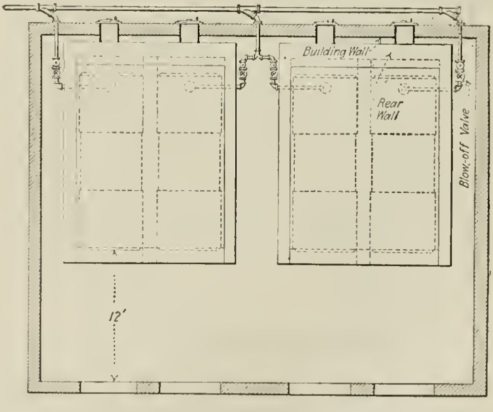
Parkersburg, W. Va.

Return-Tubular Boiler Setting

The accompanying illustration shows a method of installing horizontal return-tubular boilers which I have long advocated. The rear wall of the setting is close to the boiler-room wall and the clean-out door is opposite another door in the rear wall of the boiler room, so that all the dirt from the boiler is taken directly outdoors. This results in a reduction in the amount of room required in the building, and prevents dirt from the boilers being carried through the boiler room. Incidentally this setting prevents the space ordinarily left behind the boilers from being used as a storehouse and a general catch-all for all kinds of rubbish.

In this method of installing the boilers must be set in batteries of two, in order that the blowoff valves may be properly arranged and easily reached, but this makes it much easier to make repairs on either or both of the boilers, a situation that should be appreciated by those who have this work to do.

Another point in favor of this kind of setting is that the space between the front tube sheet and the front wall of the boiler room is considerably less than the tube length, leaving only sufficient room for such coal storage as may be required and proper firing space to handle the coal and the firing tools. In case it is required to remove tubes, they may be taken out through doors or windows. With boilers having 16-ft. tubes, the firing space may be cut to 12 ft., thus saving 4 ft. at the front, which, with the 4 ft. from the back of the boilers, makes a saving of the 8 ft. in length of the building.



PROPOSED BOILER SETTING

This will result in a very considerable saving in money and, I believe, in no reduction in the convenience of operation. As a general thing but little attention is given to boiler-room conveniences.

Boston, Mass. HENRY D. JACKSON.

Air-Compressor Losses

While watching the valve gear of a 33 x 36-in. air compressor perform recently, the inlet valve at one end appeared to be closing late. Turning the engine over by hand slowly, I found that the piston had traveled one inch when the valve closed. The compressor is equipped with an inlet valve the opening of which is effected by a cam and the release by a separate eccentric. The discharge valves are of the poppet type, and the machine ran 54 r.p.m. at the time.

The loss of one inch of the stroke meant a loss of 26.7 cu.ft. of air per minute. That in itself was worth saving, but suspecting that the effect of inertia on the closing would make the loss more serious, I rigged up an indicator connection and got diagram, Fig. 1, which showed that before closure was complete the piston had traveled 6½ in. This indicated a loss of 173.6 cu.ft. per minute, or 18 per cent. for one end. Advancing the closing eccentric resulted in the diagram, Fig. 2.

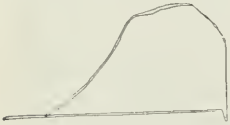


FIG. 1. FIRST DIAGRAM

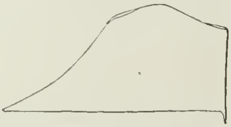


FIG. 2. SECOND DIAGRAM

This compressor is one of a pair driven by two engines connected to a common shaft with the cranks set at 90 degrees. The unloaders were set to operate one end of each compressor at the time, the unloading being abrupt and complete and the valve remaining open during the unloaded period. The governor was equipped with an oil dashpot.

When I took charge of the plant, the governor was out of commission, the engines running on the throttles; the unloaders were also out of service. After getting the governor fixed, I foolishly filled the pot with cylinder oil, thinking that would give better results in regulating. Not so, however. At every operation of the unloader the speed would increase until the governor would get control of the situation, and perhaps by that time the unloader would be ready to dump the load on again, when the speed would go in the opposite direction.

I exchanged the cylinder oil for engine oil. There may have been some improvement, but I couldn't notice it. In desperation I disconnected the dashpot from the governor with the result that the regulation is about as even as one could wish it to be, but the governor is a busy one. R. McLaren.

Toronto, Ont., Canada.

Heating of Banding Wires

The trouble experienced by C. D. Corwin from heating of the banding wires of a self-excited alternating-current generator, as related in the May 27 issue of *Power*, was probably due to eddy currents, since the armature was free from grounds.

It is possible that when the machine was first rebanded with steel wire, the wire was oxidized, which would considerably increase the resistance to the flow of eddy currents. If the wire used were free from oxide on its surface, the bands would then be comparable to a solid mass and offer a path of low resistance to the flow of eddy currents, with a resultant increase in heating from this source. Better results might have been obtained if the clips were insulated from the bands, unless they were soldered to the former.

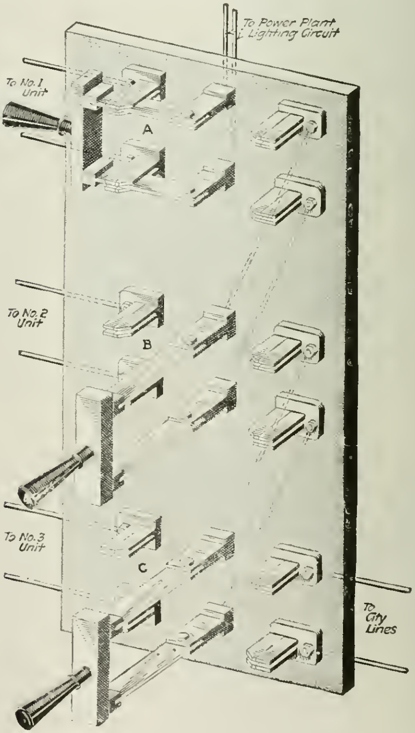
Utica, N. Y. C. R. Behringer.

Emergency Lighting Switchboard

In some industrial power plants when the circuit-breakers fly out the power plant is left in darkness, making it difficult to get around. This can be overcome by using a small switchboard, which can be installed at little expense.

In the illustration the switchblades at the left are connected to the generators and those at the right are jumper switches with the exception of the one for the city line. With this arrangement the lights can be taken from any unit that is operating, and the operator cannot throw the machines together by mistake.

In order to take current from No. 1 machine, throw the top switch *A* to left; to take current from No. 2 unit, throw the upper switch *A* to the right and the second switch *B* to the left; to take current from No. 3 generator, throw both upper switches *A* and *B* to the right and the lower switch *C* to the left.



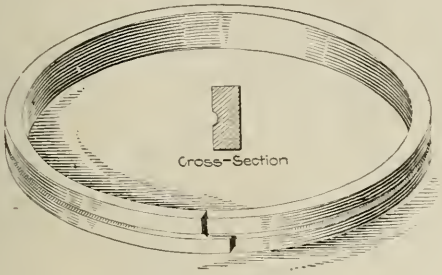
CONNECTIONS OF SWITCHBOARD

When it is necessary to take current from the city line, throw all the switches to the right. It is well to have the polarity the same on this board at all switches, as otherwise there may some time be a little difficulty, as astatic ampere meters with illuminating lamp and dial may cause a reversal in the ammeter.

Hartford, Conn. F. W. Schneider.

Diesel-Engine Piston Rings

It is generally conceded that the employment of two piston rings per groove is inadvisable on Diesel Engines. Nevertheless, an engineer is frequently found who insists on following this bad practice. His excuse, usually, is that a broad single ring has a tendency to scrape the oil off the cylinder walls, causing worn liners.



GROOVED PISTON RING

It must be admitted that many instances have occurred where the broad ring was guilty of doing this. The best remedy, however, is not the use of two rings per groove, but the engineer should file or cut a small groove on the circumference of the ring about midway on the wearing surface as shown in the accompanying illustration. This oil groove serves to break the width of the ring surface and assists in distributing the lubricating oil. E. E. SNOW.

Philadelphia, Penn.

Keeping Feed-Water Heater Clean

In line with the suggestions offered by L. A. Higgins on page 502 of *Power* for Apr. 2 the following is submitted:

I have a 200-hp. vertical heater with a separator directly above it. The original packing on the upper head of this heater lasted 23 years and that on the lower head 24 years. When these were renewed, there was absolutely no accumulation of cylinder oil on the coils in the heater. I have a 300-hp. heater with a separator above it in exactly the same position. This has been in service for 17 years. The exhaust steam from three engines, five pumps and an air compressor passes through these heaters, yet there is no accumulation of cylinder oil in the boilers. Is not this more or less proof that both heaters and separators are in the right place?

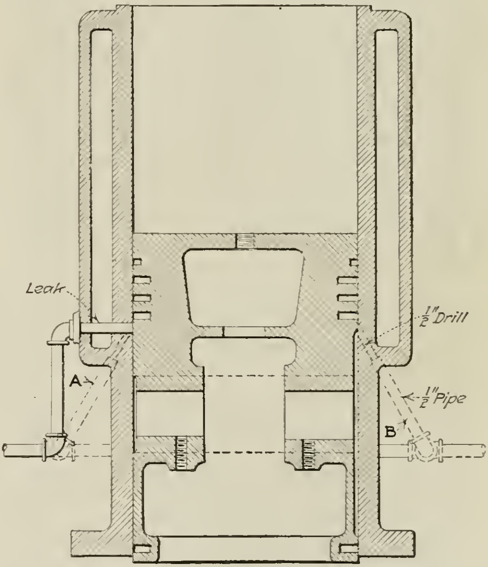
In my practice as a consulting engineer I was requested to devise means for cleansing the exhaust steam from a large factory engine, and recommended a certain separator, advising that it be located just beyond the heater. Several months afterward word came that the separator was not satisfactory. Investigation showed that the instructions had been disregarded and the separator located near the engine. It was taken out and placed beyond the heater. Some time afterward it was reported that the exhaust steam was perfectly clean, although no other change had been made. Although the change was expensive, it has proved a good investment. W. H. WAKEMAN.

New Haven, Conn.

Experience with Producer-Gas Engine

Here is a peculiar experience (though not my own) with a producer-gas engine:

It seems that all at once considerable water was noticed in the crank case of a 100-hp. three-cylinder vertical engine. The oil level was abnormally high for no apparent reason, and search revealed the presence of considerable water in the crank case. Where did this water come from? It was drawn off, and when the engine was started water was seen to be rising again gradually. This time a search revealed water coming from around the oil ring at the bottom of the piston. It was decided that only a cracked cylinder could produce this, and accordingly a new cylinder was ordered and installed. The old one lay around for some time, and suddenly one of the other cylinders began to show signs of the same trouble. This time the chief began to do some thinking. As it was during the war and new cylinders could not be obtained readily, the old one was made ready for a test by water pressure to determine just where the crack was. It was found to be coming from the nipple that was screwed through the outer wall of the jacket, through the water space and the inner wall of the cylinder. This was a ½-in. nipple and was found to be corroded through in one spot. It was not a cracked cylinder wall as was at first supposed. Removing the nipple, putting in a brass one and making a tight job made a good cylinder for emergencies. It was a simple matter to make new nipples for the other two cylinders and a few more for emergencies.



HOW OIL-FUEL LINES WERE RECONSTRUCTED

The illustration shows the location of the leak in the nipple, also the other details of the oil-feed lines as now constructed. These lines, *A* and *B*, do not pierce the water jacket as is the case in the old style of construction and for that reason make a better arrangement. D. L. FAGNAN.

New York City.

Engine Crosshead Pounds

I advise Mr. Hollis to give his engine a little more compression on both ends, also a little earlier steam admission on the end of the cylinder giving the left-hand diagram, shown on page 827 of the May 27 issue of *Power*.

In regard to the necessity of keying up the crosshead brasses every other morning, I suggest that he remove the brasses and refit them to the wristpin, as they are doubtless pinching on the top and bottom and do not have a bearing at the sides.

Willsboro, N. Y. C. RICHARD WARD.

The diagram submitted by E. Hollis shows inadequate compression for an engine making 81 turns per minute. An engine running at that speed should have the compression run up to at least one-quarter the height of the admission line. To obtain the required compression in this engine without restricting the release due to later opening, it will be necessary to advance the eccentric. This will cause an earlier opening of the steam valves, which can be remedied by lengthening the radial rods and shortening the dashpot rods. To obtain smooth running with an engine running under, it is essential that there be no play between the guides and the crosshead shoes.

In reference to the engine pounding only on one end, I would say that the compression is less effective on that end. In other words, the thrust on the bearings has not been reversed before the steam is admitted for the opposite stroke. When the boiler pressure is increased, the knock increases because the initial pressure against the piston is greater, resulting in a greater impact against the wristpin. In some cases slightly late admission where the compression has not been effective will alleviate a pound. This is because the reciprocating parts are in motion when the steam is admitted against the piston. J. W. DICKSON.

Memphis, Tenn.

Having read the letter of E. Hollis, I submit the following facts for consideration.

A friend had charge of a 20 x 48-in. engine. The speed was 60 r.p.m. and the boiler pressure was 80 lb. The crankpin began to heat badly. Cylinder oil was substituted for engine oil, without securing better results; then castor oil was used, followed by white lead. As it was necessary to shut down every day to cool off this pin, the trouble proved expensive. The engineer recommended a set of new crankpin brasses, but after these were fitted the crankpin continued to heat as before. He then called for a new crankpin, but this was no better than the old one.

All this trouble called for much overtime and extra work and worry, until the engineer was obliged to take a vacation. The substitute engineer was given permission to make any change that he desired during the absence of the regular man. He proceeded to take some indicator diagrams, which were practically like those shown by Mr. Hollis, except that there was no compression. Connections between the wristplate and the exhaust valves were lengthened, thus increasing the compression until it was equal to about one-half of the initial pressure. The crankpin did not heat after this change was made, using a good engine oil only, and no other changes were wanted or made. The engine did not pound either before or after the change was made. W. H. WAKEMAN.

New Haven, Conn.

Discussing Mr. Hollis' engine trouble, it looks as though both exhaust valves were leaking and that both close too late, especially the one on the left diagram. I advise adjusting the valve connections to close the exhaust valves earlier and thus get more compression, which is the first step in relieving the pound.

Next, see that the piston rod is parallel with the bottom guide when the crank is on the crank-end center, either by putting a level on the rod and guide or by using a caliper between the piston rod and the bottom guide, bringing the rod level and parallel to the guide by adjusting the wedge on the bottom shoe to raise the crosshead. The rod will then run true through the stuffing-box. If the crosshead is already in line and parallel, the top shoe should be adjusted so that it will be as tight as it will run without heating. This is necessary on all engines running under.

As the engine is adjusted by means of a key and strap, they may be so pounded up that they will not stay tight with the engine carrying a varying load. It would be well to take out the key and file the edges where they pass through the strap, running the file lengthwise of the key, thus making it fit more perfectly. Perhaps the setscrew has worn a bad spot in the side of the key, which requires scraping out to make the key hold better. See that the nut on the end of the wristpin has not loosened and allowed the crosshead pin to work loose in the crosshead.

If these mentioned remedies fail to give relief, key the wristpin brasses up as tight as it is safe to run, start the engine slowly and hold the hand over the end of the crosshead pin, allowing the fingers to touch the crosshead at the same time as the pin when the crosshead reaches the end of the stroke and while the crank is passing the centers on both ends. In this way one can tell if the crosshead pin is loose in one side of the crosshead, which will also cause a pound. If it is loose, it should be refitted at once to prevent the hole in that side being pounded out of true beyond repair and to avoid the possibility of the crosshead being later cracked on the other side by the bending movement of the crosshead pin in the tight side.

Again, while the engine is running slowly notice if as the crosshead reaches the ends of the stroke, it jumps sidewise. If it does, the brasses are worn out of true and this throws the connecting-rod out at a slight angle, causing the crosshead to jump sidewise. The brasses should be taken out and trued up on the bearing surface and squared up if necessary to keep the thrust of the piston rod and connecting-rod on a straight line.

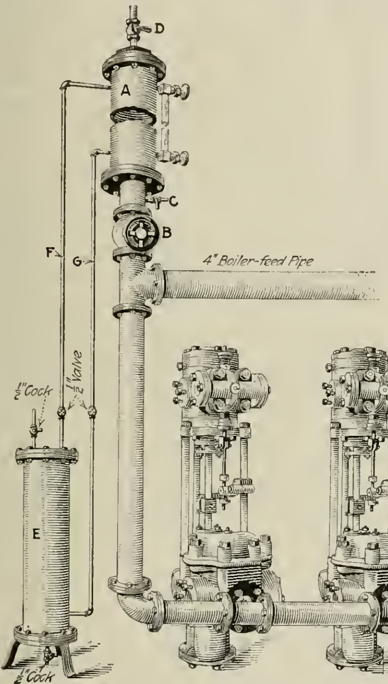
If, after filing the key and strap true, the former should protrude through the strap, it may be necessary to put a small sheet-steel or tin strip in back of the key to hold it up in position until a new one can be obtained. Also see that there is no obstruction for the key to strike against below the crosshead, if the key extends through the strap too far. The key may be extending far enough through the strap to strike the crosshead when the connecting-rod reaches its greatest angle when passing the quarter, which will also cause some pound and it may produce a serious break.

Cambridge, Mass. R. A. CULTRA.

Maintaining Air in Air Chambers

The desirability of air chambers on boiler-feed lines, at least when reciprocating pumps are used, is, I think, recognized by most engineers. The fact that they have been abandoned in many plants is probably due to the difficulty of maintaining the necessary air cushion and the engineer has balked at the thought of purchasing an expensive and troublesome air pump. So the jarring and hammering of the feed lines has been regarded as a necessary evil. Perhaps the following may be of value:

At a plant where I was recently employed, the boilers were normally fed by a four-stage centrifugal pump, with a large vertical reciprocating pump as a stand-by. Both of these machines were put out of service by sand which found its way from the filtration plant, and two small reciprocating pumps of one-half the capacity of the large machines were installed and put to work. These were connected to a common suction pipe about 80 ft. long, and it was at once apparent that it would be necessary to allow them to fall into step owing to the pulsating action of the water column in the suction pipe. The effect of this synchronizing was, however, to set up heavy pulsation on the discharge side, which caused the boiler-feed check valves to clatter and which also broke a tube in the economizer.



ARRANGEMENT OF AIR CHARGING CHAMBERS

An air chamber *A* was then placed on the discharge side, consisting of 6 ft. of 8-in. pipe with a plug at the top, a water glass being fitted so that the air volume could be observed. This air chamber was put in operation by first closing a 4-in. valve *B* at the bottom and drawing the water from it by means of ½-in. cock *C* just above the latter valve, while the air entered through another ½-in. cock *D* at the top. The 4-in. valve was then opened and a small air cushion formed.

Although no leak could be detected, the air volume gradually decreased, due perhaps to its absorption by the water, and the necessity for some kind of air pump was obvious. The average pressure in the feed line was about 200 lb. and the air compression would furnish only 65 lb. A displacement rig was therefore installed, the material for which was mostly obtained from the scrap pile. This consisted of another section of 8-in. pipe *E* set up in a vertical position but about 10 ft. lower than the air chamber. A ½-in. cock was placed at both top and bottom and ½-in. pipes *F* and *G* connecting the top and bottom of the two chambers, with valves placed near the bottom chamber. The air in the latter was displaced by the water which came down the ½-in. pipes until the pressures were equalized, and then the compressed air ascended in a few seconds to the upper chamber. A few operations sufficed to fill the latter three-quarters full of compressed air, and a few minutes' daily attention was all that was required to keep it there. All pulsation in the feed lines disappeared, and the air chamber and its home-made filling device were retained in service even after the centrifugal pump was again placed in commission.

Hawkesbury, Ont., Canada. G. B. SOMER.

Shaft Alignment

The article in the June 10 issue, by Mr. Dahlstrand, on the subject of shaft alignment and its importance, was particularly timely and instructive, inasmuch as this question is one that does not receive from the average engineer the attention that it warrants. Mr. Dahlstrand states that a flexible coupling will not take care of misalignment, but that it will take care of movement in an axial direction. While most so-called flexible couplings will allow an axial movement of one-half relative to the other when running at no load, when load is applied we are confronted with a totally different proposition. In some designs the coupling not only does not respond to longitudinal movement, but actually creates an end thrust in itself, tending to force the two halves apart.

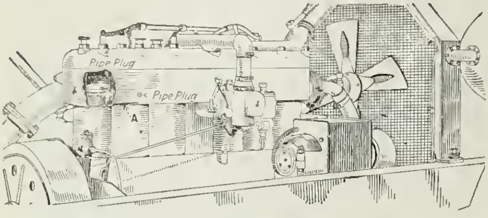
Of course it is appreciated that a carefully machined and well-designed coupling operating under forced lubrication will allow comparatively free movement endwise, but for small work such as in turbine-driven auxiliaries it is poor engineering to rely upon free endwise motion with the standard type of coupling commonly used for this work. One other criticism that presents itself is the low estimate made by Mr. Dahlstrand of the percentage of troubles that are due to misalignment. I made a very careful investigation of this some time ago, regarding troubles covering several hundred machines and my estimate is that this percentage should be nearer 80 to 90 per cent. and I believe this percentage will be confirmed by several of the pump makers who have had experience with this class of apparatus.

If, as Mr. Dahlstrand points out (and he expresses the opinion of most engineers today), the flexible coupling will not take care of misalignment, then why go to the complication of same and why not have a solid coupling with the elimination of at least one of the bearings? For small auxiliary work more than two bearings on the average equipments are unnecessary. W. J. A. LONDON.

Springfield, Mass.

Repairing a Cracked Water Jacket

The article entitled, "Repairing a Cracked Water Jacket," appearing a short time ago in an issue of *Power*, prompts me to explain the manner in which a somewhat similar crack was repaired by means apparently more simple than those described in the article under discussion. Nothing original is claimed for the method used, although, to my knowledge, it had never been used before under similar circumstances. A couple of acquaintances of mine have since used the method and it proved successful in both cases.



ENGINE SHOWING POSITION OF WATER-JACKET CRACK

This particular engine was in a car. As soon as cold weather set in, for fear of a freeze-up the jacket was thoroughly drained. In order to drain this particular type of engine, it is necessary to open the pet-cock underneath the pump and also to remove two small pipe plugs on the opposite side of the casting, as shown in the sketch. To insure a thorough draining, the pet-cock was opened, the two plugs removed, the left front wheel of the car jacked up several inches; all according to the instructions for draining this type of engine. The car was left in the garage for about one week, during which there were two days of zero weather. Upon the return of warmer weather it was decided to drive the car. The plugs were therefore returned to their respective places, the pet-cock closed underneath the pump, and the jacket filled with water.

A very bad leak was immediately noticed at the point *A*. The crack was about three inches long and in a somewhat inaccessible place. The jacket was drained, and an examination was made to discover the cause of the crack.

A wire was introduced in one pipe-plug hole as a feeler, and there appeared to be a bank of sand or some obstruction in the water chamber. By poking this wire in each of the plug holes and then flushing out the water jacket nearly a cupful of what apparently was coarse sand was obtained. The explanation that presented itself for the freezing and bursting of this jacket was that this sand had never been thoroughly cleaned out and that it had retained sufficient water so that upon freezing its expansion broke the casting.

To make the repair a small three-cornered file with the end broken off was used to clean the paint from the casting adjacent to the crack and to clean out the edges of the crack. A few cents' worth of sal ammoniac powder was then mixed with very fine cast-iron filings in an indiscriminate proportion. The water jacket was then filled sufficiently to permit water to trickle through the crack, after which the jacket was drained. This was done in order to wet the surface of the crack. The mixture of sal ammoniac and iron filings was then rubbed in the crack by means of the thumb and finger, working the mixture in as much as possible and finally leaving on as much as would adhere conveniently. It was hoped that the moisture in this crack would naturally, by capillary attraction, gradually work this solution of sal ammoniac into the crack to the full extent of the thickness of the casting. The car was allowed to stand for about four days, and then the superfluous sal ammoniac on the outside was scraped off. Black machinery enamel was used to cover over the rusted appearance of the crack as well as to prevent any further outside rusting. The jacket was then filled, and up to the present writing, which is more than a year since the job was done, no leakage has appeared.

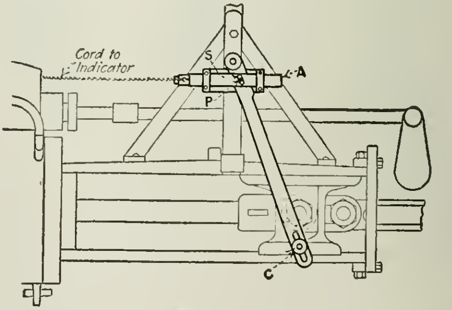
The action which took place was of course merely a rusting-in process. As there is very little pressure in the water jacket at any time, there is no reason why this type of repair is not suited to any such break, and it is a convenient as well as an inexpensive method, as compared with taking the engine out and having a proper weld made by use of the oxyacetylene torch, which is an expensive method as well as one which is likely to cause a distortion in some part of the engine unless the job is done by an experienced man and extreme care used in heating the entire cylinder block.

There is no reason why the foregoing method should not be successful in cases of a similar nature if sufficient time is allowed for the rusting-in process.

Groton, N. Y. C. D. CORWIN.

Altering a Reducing Motion

The inaccuracy of a reducing motion having a slot in the lower end of the lever, referred to on page 988, June 24 issue of *Power*, is eliminated by the arrangement shown in the sketch. *A* is a sliding piece with pin *P* moved by a second slot *S* situated higher up in the same lever, as illustrated. Horizontal motion of the pin and sliding piece *A* is always in proportion to movement of the pin *C* in the crosshead. O. TANFEU.



CORRECT REDUCING MOTION WITH SLOTTED LEVER

Jamaica, B. W. I.

[This type of reducing gear is perfect only so long as there is no lost motion between the pins and the sides of the slots, and the slide *A* is guided parallel with the motion of the crosshead and with the cord to the indicator taken off parallel with the stroke.—Editor.]

Inquiries of General Interest

Eccentric Ahead or Behind Crank—When is the crank of an engine said to follow the eccentric or the eccentric to follow the crank? H. C. R.

The angle that an eccentric makes with the crank is indicated by the position of the "high side" of the eccentric with reference to the crank. The crank is said to follow the eccentric or the eccentric to be ahead of the crank, when the eccentric is less than 180 deg. ahead, measuring in the direction of rotation of the shaft. The eccentric is said to follow the crank or the crank to be ahead of the eccentric when the crank is less than 180 deg. ahead of the eccentric, measuring in the direction of rotation.

Boiler Corrosion from Feeding Heating Returns—We are troubled with pitting of the front lower sheet of our horizontal return-tubular boiler and believe it may be due to feeding the condensation returned from an exhaust steam-heating apparatus, as the corrosion does not seem to continue after the heating season is over. How can the trouble be cured? S. K.

Corrosion from refeeding condensate might be more rapid because the water is purer, or from free acid due to adulterants in the engine cylinder oil which find their way into the boiler, but in either case all parts of the water space would be affected. If the corrosion is mainly confined to pitting of the fire sheets, they may have been overheated from presence of oil carried over from the exhaust, and once burnt, their corrosion would proceed more rapidly. Better means should be employed for removing oil from the exhaust and condensate before refeeding. Use engine cylinder oil sparingly, wash the boiler more frequently and if the boiler has to be forced, do not feed the return water from the exhaust-steam heating system.

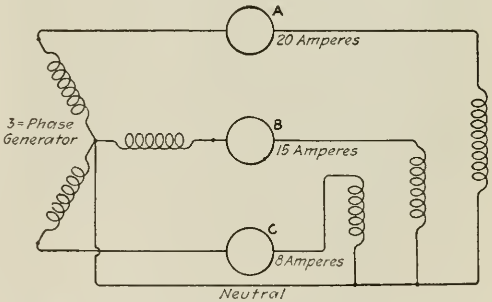
Saturated and Superheated Steam—What is meant by saturated and superheated steam? H. M. C.

Steam that is at the evaporation temperature corresponding to its pressure is said to be "saturated steam." When steam formed in a boiler rises from the surface of the water, it is saturated, and will remain so as long as it is in contact with the water, and so long as the steam is in a boiler in close communication with the water it cannot be other than saturated, for any attempt to heat the steam to a higher temperature will fail, as the heat will be transmitted to the water and cause further evaporation. Saturated steam may be perfectly dry, or it may be "wet" saturated steam containing suspended particles of water, just as water is suspended in the atmosphere during a fog. Whenever steam is mentioned without qualification, it is understood to be dry saturated steam. Superheated steam is steam whose temperature is higher than the evaporation temperature corresponding with its pressure, and to effect superheating of saturated steam it must be heated away from water to a higher temperature than the temperature of saturated steam of the same pressure and without changing the pressure.

Setting Slide Valve Without Uncovering—How can the valve of a slide valve engine be set without uncovering the valve chest? W. R.

The valve can be set approximately without uncovering the valve, from judgment of the equality of flow of steam from the cylinder waste cocks for determining when the steam ports are nearly covered by the admission edges of the valve. With the cylinder waste cocks wide open and the throttle valve opened only a very little, place the crosshead so the piston will be at a point of the stroke first in one end and then in the other end of the cylinder to obtain a very small but apparently equal discharge of steam from the waste cocks, and for each position, make a mark on the valve rod at the gland of its stuffing-box and locate a mark midway between those marks. Then turn the engine over slowly and mark the valve rod in the same manner when it is farthest in and out of the stuffing-box and locate a mark midway between these marks. If the first and second middle marks do not agree, it is because the valve travels more to one side than to the other side of the center of the ports. If the mark that represents the middle of the valve travel falls on the steam chest side of the first middle mark, the distance between the marks shows the amount that the valve rod is too long, or falling on the crank side, the distance shows the amount the rod is too short for giving symmetrical travel of the valve, and the difference should be rectified by adjustment of the length of the valve rod or of the eccentric rod. After thus equalizing the valve travel, place the engine on a center and turn the eccentric on the shaft in the direction of rotation of the engine and set the eccentric on the shaft when discharge of steam from the waste cock indicates that the valve is beginning to open and determine whether the same opening of the valve has been obtained when the engine is placed on the other center.

Current in the Neutral of a Three-Phase System—Three ammeters, A, B and C, are connected in a four-wire three-phase system and read 20, 15 and 8 amperes respectively, as shown in the figure. What is the current in the neutral conductor if the power factor of each load is unity? A. R. C.



When the power factor of the system is unity, the current in the neutral of a four-wire three-phase system is always equal to

$$I_N = \sqrt{(I_A - I_B)^2 + (I_B - I_C)^2 + 2(I_A - I_B) \times (I_B - I_C) \times \cos 60 \text{ deg.}}$$

where I_A, the reading of ammeter A, equals 20 amperes; I_B, the reading of ammeter B, equals 15 amperes; and I_C, the reading of ammeter C, equals 8 amperes. Then,

$$I_N = \sqrt{(20-15)^2 + (15-8)^2 + 2(20-15) \times (15-8) \times 0.5}$$

$$= \sqrt{5^2 + 7^2 + (2 \times 5 \times 7 \times 0.5)} = 10.44 \text{ amperes.}$$

It should be remembered that to use the arrangement of symbols in the formula it is necessary that I_A have the highest value, I_B the intermediate value and I_C the smallest value.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Dirt in Coal*

In different localities, and frequently in the same locality under different conditions of mining and preparation, the ash content in coal varies widely. The normal amount of ash may be considered as that found in the face sample of the seam proper; the excess ash is that which is added to the coal from the roof or bottom in the process of mining and which is not eliminated before the coal leaves the mine. Lump coal made over a 1¼-in. screen usually shows the normal percentage of ash, while the 1¼-in. screenings in most cases show 1½ times the percentage of ash contained in the lump.

In screenings the ash content can be reduced nearly to that of the screened lump by the use of a jig gravity washer, with an ample water supply and a convenient place to deposit the refuse. However, the washing of screenings has been considered too expensive while the price of all coal was low, but since prices have increased 60 per cent. and more, and will probably remain so, it may be profitable to eliminate the excess ash by washing in the vicinity of the mines, thereby saving the long haul of inert material to points where the coal is finally consumed, the cost of which would be about six mills per ton mile. The following data giving ash and B.t.u. content of coal from a bituminous mine in the Central West district illustrates how the ash in screenings can be reduced by washing:

COAL FROM ONE MINE IN CENTRAL WEST

	Ash, Per Cent.	B.t.u.
Dry or unwashed screenings.	22.61	8,895
Washed screenings.	14.05	10,085
Lump.	12.39	10,499

In mine run and prepared sizes made over 1¼-in. screen, the excess ash can be removed easily by hand by the miner at the working face when loading into the mine cars, or by having men or boys working on picking tables or belts while the coal is passing to the railroad car.

This work can be looked after by a regularly assigned fuel inspector. The railroad employing the speaker used a system of close inspection with suggestions to the mine superintendents on the ground while the coal is being loaded. As a result of this effort, the impurities removable by hand-picking and based on actual carload tests have been reduced from an average of 2.733 per cent. in the year 1911 to an average of 1.535 per cent. This, applied to a consumption of 4,000,000 tons of coal used annually, represents 47,920 tons less ash, which would have required the use of 958 fifty-ton cars to move it. The transportation cost of moving this excess ash an average distance of 266 miles, based on an "out of pocket" cost of five mills per net ton mile, equaled $63,733.60 per annum. This, however, was but the lesser saving.

TABLE I. ANALYSES OF COALS

Test Number	Moisture, Per Cent.	Volatile Matter, Per Cent.	Fixed Carbon, Per Cent.	Ash, Per Cent.	Sulphur, Per Cent.	B.t.u.	Clinker
1	3.37	31.31	55.19	9.63	0.64	12,325	No
2	6.02	30.00	53.50	10.30	1.30	12,136	No
3	4.61	31.35	54.05	10.00	1.19	12,368	No
4	2.92	33.10	51.25	12.73	2.96	12,389	Yes
5	4.99	39.22	43.99	11.80	4.43	11,768	Slightly
6	3.41	37.12	45.62	13.85	4.02	11,842	Yes
7	5.13	37.70	44.31	12.80	4.52	11,693	Yes
8	2.86	36.04	43.14	17.96	4.58	11,124	Yes
9	8.49	34.87	48.16	8.48	1.47	12,251	No
10	4.68	38.59	44.24	12.49	4.50	11,921	Yes

Taking the established estimate of increase in efficiency of 1½ per cent. for each reduction of 1 per cent. in ash, the saving from this source (that is, increased evaporative efficiency) with coal at a delivered price of $3.68 per ton, equaled $264,518.40, or a total saving of $328,252 per annum. What the measure of the economies following from reduced engine failures and reduction in engine house expenses amounted to is difficult of computation.

Effective combustion of coal depends largely on the nature and percentage of impurities it contains, especially so if the ash has a tendency to clinker, which is dependent on the percentage of silica, iron and lime in its composition. Tables I and II give analyses of coal and ash used in ten burning tests from ten different mines in Illinois and Indiana.

By referring to the column showing the clinkering and nonclinkering coals and then making a review of the ash table, it will be observed that the coals with nonclinkering ash are low in both sulphur and lime. In burning they did not clinker in a dazzling white fire of an approximate temperature of 2900 deg. F., while the ash in the clinkering coals fused at a firebox temperature of approximately 2200 deg. F., which indicates clearly that when the sulphur and lime content exist in high proportion to the silica, iron and aluminum oxides, it is the direct cause of the ash fusing at the lower temperature.

TABLE II. ANALYSES OF ASH

Test Number	Sulphur (S) Per Cent.	Silica Oxide (SiO_2) Per Cent.	Iron Oxide (Fe_2O_3) Per Cent.	Aluminum Oxide (Al_2O_3) Per Cent.	Calcium Oxide (Lime) (CaO) Per Cent.	Magnesium Oxide (MgO) Per Cent.	Color of Ash
1	0.64	59.0	3.1	31.0	5.6	1.3	White
2	1.30	55.2	8.3	26.6	7.3	1.3	White
3	1.19	56.1	8.1	27.2	5.4	0.9	Light gray
4	2.96	45.4	25.3	16.9	11.6	0.8	Reddish gray
5	4.43	49.1	32.2	13.5	4.5	1.4	Reddish gray
6	4.02	35.1	22.4	10.2	30.8	1.5	Reddish gray
7	4.52	43.3	24.1	9.0	19.9	1.2	Reddish gray
8	4.58	44.8	20.3	18.6	16.4	1.5	Reddish gray
9	1.47	45.8	20.2	28.3	5.4	0.0	White
10	4.50	27.1	52.3	14.1	4.4	1.2	Dark gray
Fusing tem. deg. F.	239	3227	2840	3416	3452	3882	....

From the bottom line of Table II, giving the fusing temperature of the sulphur and the different oxides, it will be seen that by taking each element separately the fusing point is at a higher temperature than usually obtains in the furnace of a boiler. However, by combining these elements in proper proportion with the sulphur, fusion at a much lower temperature will take place.

In these ten experiments the conditions as to draft, etc., were identical. It has been observed since, however, that the coals containing the clinkering ash will give better results both as to combustion and reduction of slag in the ash by increasing the draft. More air through the fuel bed has a tendency to keep the temperature of the fire below the fusing point of the ash. Hence it is good policy to assign clinkering coals to a lower class of service.

Engineering Societies Pass Resolutions on Andrew Carnegie

Andrew Carnegie's death August 11, 1919, at Lenox, Massachusetts, brought to its close a career which greatly advanced all the engineering arts and sciences. By the introduction into the United States of the Bessemer process for the production of steel and by the establishment and development of steel plants, which became the greatest in the world, he made available for engineers the most useful modern material for engineering construction. In the successful conduct of many industrial enterprises, he amassed great wealth, the possession of which he came to regard with deep seriousness as a public trusteeship. He devoted himself to the distribution of large portions of his fortune to projects for the benefit of mankind. He distributed his wealth not only in many directions, but also with the exercise of great wisdom based on careful investigation. His munificence provided large funds for the building of a home for the great national engineering societies and many associate societies. He was an honorary member of the American Institute of Mining and Metallurgical Engineers and American Society of Mechanical Engineers. He was personally known and loved by many engineers. In view of these facts, be it

Resolved, That the American Societies of Civil, Mining, Metallurgical, Mechanical and Electrical Engineers, the United Engineering Society and the Engineers' Club, herein express to the family of Mr. Carnegie and record their sincere appreciation of the great contributions of Andrew Carnegie to the advancement of engineering, and of his friendly assistance in making possible beautiful homes for the Engineering Societies and the Engineers' Club, thus fostering the spirit of unity in the profession.

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*Abstract of paper read before the International Railway Fuel Association, Chicago, May 19-22, by L. J. Joffray, general fuel inspector of the Illinois Central Railroad.

A. I. E. E. Development Committee Presents Reports

At a meeting of the board of directors of the American Institute of Electrical Engineers, held Aug. 12th, 1919, a resolution was adopted, that the report of the Committee on Development be received, that the recommendations in the report of the Committee on Development, dated Aug. 12, 1919, be approved in principle and that the president refer the various parts of the report to qualified committees, either existing or special, with the request that these committees formulate definite plans of procedure with estimates of expense involved, for bringing into effect such changes in present practice as the committees deem desirable; the Committee on Development to be continued, with particular reference to the consideration of the institute's participation in joint activities with various other engineering and technical organizations.

The report of the Committee on Development as received by the board of directors Aug. 12 follows closely the general outline of the committee's recommendation published on page 296 of Aug. 12 issue of *Power*. Following are the parts of the report that deal with the change in the *Proceedings* and the holding of an Engineering Congress.

There is an almost unanimous view that the *Proceedings* do not seem sufficient to interest the membership at large, and the suggestions of a remedy cover a wide range of possibilities. The value of the class of papers which heretofore have been published in the *Proceedings* as representing advances in the art and constitute a record of progress is appreciated and it is insisted that the high standard of the institute should be maintained but it is believed that this view is not inconsistent with a recognition of the rights of 90 per cent or perhaps 95 per cent of the total membership who are concerned with the day to day engineering problems and with the personal side of engineering relationships. It is believed that if the *Proceedings* can be properly expanded that publication will serve better to both bind the present membership closer together and furnish an added incentive for engineers not already members to join. The Development Committee has devoted a great deal of time to discussions of this matter but feels that with the recommendations of the various sections and the stenographic report of the Lake Placid meetings to be considered further study should be given to this matter. They, therefore, submit the following recommendations, to wit:

That the Publication Committee be asked to consider and recommend to the board improvements in the present plan of publishing the *Proceedings* and the *Transactions* and of printing and distributing copies of institute, sections and branch papers.

That in dealing with these questions the Publication Committee consider:

A. Enlarging the editorial and executive publication staff for the purpose of expanding the *Proceedings* to contain additional live matter of interest and value to the membership as a whole without giving less importance to the principal activities of the institute, that is, the promotion of the fundamental advance in the art and the encouragement of original investigation in the field of electricity.

B. Publishing all institute papers and occasional papers of unusual broad general interest and value from sections or from other sources; publishing a set of abstracts of every paper presented to every section so that each month there will be a complete record of this class of institute activity.

C. Eliminating as far as may be feasible the duplication of expense now incurred by twice publishing the papers heretofore distributed (in both the *Proceedings* and the *Transactions*) but without depriving the membership of the *Transactions* in some form.

D. Publishing discussions in the *Proceedings*.

E. Endeavoring to increase the revenue producing capacity of the *Proceedings* by expanding its advertising policy and if necessary changing its page dimensions.

F. Printing pamphlet copies of some or all section and perhaps branch papers and economizing on the cost of printing institute and such section and branch papers by limiting their quantity and free distribution while making them available for the membership.

That there be inaugurated the custom of periodically holding an Engineering Congress, the delegates to which should be selected from all parts of the country under a plan to be developed for suitable representation, this congress to consider and take action on such matters of general interest to engineers and to the public as may merit its attention and as have been previously advertised, for a sufficient length of time, to permit locals everywhere to give them consideration and when possible to send instructed delegates.

The second reason, namely, a possible modification of the engineering curricula of our technical schools and colleges while perhaps of underlying and fundamental importance not only did not have the general consideration of many of the sections in their local deliberations but was nearly crowded off the Lake Placid program by the press of other matters. It was, however, the unanimous view of the members attending the sessions at Lake Placid that this matter should receive early and thorough consideration by the institute, and the following preamble and resolution was there presented and adopted:

"As the individual engineer cannot look for greater public recognition or individual advancement than his training and fitness warrant,

And, in the belief that the bigger development of the profession consists in broader social and public service by publicly-minded engineers,

Recognizing that on the one hand young engineers are employed for too long a period at work which does not stress their capabilities and, on the other, that the demands of industry for ever-increasing numbers of technicians must be supplied,

And having in mind the excellent precedents established by the medical and legal professions,

This committee would welcome the establishment at the earliest date practicable of a normal six years' collegiate course in engineering, two years of which at the least should be devoted to training in the humane arts and sciences including, for example, Political Science, Economics, History and General Letters; the last four years being devoted to sound training in the sciences and in only the fundamentals of diversified engineering.

With or prior to such a development we would endorse a program for the marked extension of vocational training in the industrial centers in order that the needs of industry may be met.

To the accomplishment of these ends this committee requests the appointment of representatives to serve on a joint committee of engineering organizations to promote such a national educational program as shall provide for the future necessities of the engineering profession consistent with the needs of society."

N. E. L. A. New England Section to Hold Eleventh Annual Convention

From Sept. 22 to Sept. 24 the New England Section of the National Electric Light Association will hold its 11th annual convention at New London, Conn., with the Hotel Griswold as headquarters. In the tentative program that has been arranged is included the following:

Monday, Sept. 22, 10 a.m.—President's address, George B. Leland; treasurer's report, Bowen Tufts; secretary's report, Miss O. A. Bursiel. Standing Committee reports: "Advertising and Publicity," L. D. Gibbs, chairman; "Accident Prevention," H. W. Moses, chairman; Membership, Merle R. Griffith, chairman; "The Purchase of Coal," by Perry Barker; "High-Power Switching Apparatus Used in Connection with Large Systems," by Fred L. Hunt.

Monday, Sept. 22, 2 p.m.—Session in charge of and assisted by members under forty years of age; chairman, F. A. Belden; assistant chairman, Leavitt L. Edgar. (Topics not yet announced.)

Tuesday, Sept. 23, 10 a.m.—Commercial session; Commercial Section Committeee report, C. E. Greenwood, chairman. (To be followed by discussion of commercial subjects.)

Tuesday, Sept. 23, 2 p.m.—Commercial session—"The Use of the Electric Range in a Small City," by E. F. Putnam; "Electric Ranges and Water Heating," by M. C. Osborn.

Tuesday, Sept. 23, 7 p.m.—Dinner. This occasion will be similar in dignity and importance to previous banquets. Dinner will be followed by public policy session—A. B. Lisle, chairman Public Policy Committee; address by R. H. Ballard, president National Electric Light Association; "Municipal Ownership and Socialism," by F. G. R. Gordon. Representatives of New England public service commissions will be guests.

Wednesday, Sept. 24, 10 a.m.—"High-Tension Cables," by Wallace S. Clark, followed by discussion by operating men; "The Control and Improvement of Power Factor," by Nicholas Stahl, followed by discussion by operating men; "Planning for Power as Applied to New England," by Prof. Charles F. Scott.

Wednesday, Sept. 24, 2 p.m.—Accounting Section Committee report, Frederick E. Webster, chairman; Electric Vehicle Committee report, Day Baker, chairman; annual meeting class A members; election of officers.

Government Needs Skilled Men

The new naval ordnance plant at South Charleston, W. Va., is now about to begin the manufacture of armor plate, and forgings for guns of large caliber, entirely new lines of work for Government plants. The South Charleston plant is a $19,000,000 enterprise occupying more than 200 acres of land. It will be ready for making armor and heavy forgings as soon as the assembling of the necessary working force can be completed. Disturbed labor conditions incident to the war have been responsible for a delay in getting this work started. The new plant is equipped with every modern appliance for the manufacture of its specialties, and will turn out annually 50,000 tons of armor plate, guns, projectiles and miscellaneous ordnance forgings.

Engineers, metallurgists and mill and machine-shop men will be interested in the positions which are to be filled in the supervisory and subordinate forces. Detailed information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or from the secretary of the local board of civil service examiners at the post office or custom house in any of 3000 cities. Journeyman workmen and helpers should apply direct to the labor board at the South Charleston plant.

Transportation to Huntington Convention of the N. A. S. E

The transportation committee of the New York and New Jersey delegation to the national convention of the National Association of Stationary Engineers, Huntington, W. Va., Sept. 8 to 13, announces transportation arrangements.

Leave	Pennsylvania Station	3.34	p.m.,	Sunday,	Sept. 7
"	Manhattan Transfer	3.46	"	"	"
"	Market St., Newark	3.57	"	"	"
"	Elizabeth	4.07	"	"	"
"	Trenton	4.58	"	"	"
"	West Philadelphia	5.47	"	"	"
Arrive	Washington	9.15	"	"	"
"	Huntington	1.20	p.m.,	Monday,	Sept. 8

The fare is $19.98, tax $1.60, lower berth $3.50, tax $0.28, total $25.36; upper berth $2.80, tax $0.22; drawing room $13.00, tax $1.04.

The delegates will have at least three cars to themselves, and will be joined by the New England delegation in New York or Washington. Arrangements have been made for delegates to meet at window No. 18, Friday, Sept. 5, 8 to 9.30 p.m., to pay for and receive tickets. J. D. Taylor, chairman, Museum of Art, 5th Ave. at 82d St., will make reservations upon receipt of full amount, and will hold them until train time for those who cannot get to the ticket office.

New Publications

INDUCTION COILS. By Prof. F. E. Austin. Published by the author, Hanover, N. H. Cloth; 5½ x 8½ in.; 64 pages; 45 illustrations. Price, $1.

In this little book the induction coil is treated of in theory and practice. The author has aimed to present the explanations of fundamental principles so as to enable anyone to construct induction coils to meet a variety of demands and specific requirements. The book may be divided into eleven parts, dealing with: The generation of an electromotive force by magnetic induction; magnetic circuits; primary and secondary circuits; mathematical theory of operation of induction coils; structural features; interrupters; condensers; specification for different sizes of coils; spark coils; Tesla coils; choke coils. Those interested in the construction and application of induction coils will find this book to contain considerable valuable information applicable to this class of work.

THE CONSTRUCTION OF GRAPHIC CHARTS. By John B. Peddle, Professor of Machine Design Rose Polytechnic Institute. Published by the McGraw-Hill Co., Inc., New York City. Cloth; 6 x 9¼ in.; 155 pages; illustrated

The calculating chart, or nomogram, as a means of application of formulas under different conditions has been growing in popularity with the more progressive engineer to a great extent in recent years. That such use has not been more general in the past, is due in all probability to the fact that many engineers have considered these chart forms as being of such complex mathematical nature as to be beyond the comprehension of the average operator. For the benefit of those who are rusty in mathematics an effort has been made to simplify the treatment and to illustrate in detail the various chart forms described. Beginning in Chapter 1 the simplest form of chart—those plotted on rectangular coördinates—are fully described and illustrated, followed in Chapter 2 by the alinement chart and in order the problems of charts involving three or more variables, the haxagonal index chart, proportional charts, empirical equations and the stereographic charts and solid models. The last chapter involves the principles and application of variables. The book seems admirably suited to its purpose—to acquaint the engineer with the underlying principles of the graphic chart and to instruct him in the methods of constructing such charts as might be suited to his individual needs.

Engineering Affairs

The Eccentric Firemen, L. U. No. 56, held its athletic games and picnic at Celtic Park, Long Island City, Sunday afternoon, Aug. 17. The usual large crowd witnessed the feats of the firemen.

The Association of Edison Illuminating Companies will hold its thirty-eighth convention—the first the association has held in three years—at the Griswold, Eastern Point, New London, Conn., Sept. 15-18. Among the papers to be presented will be one on "Fuel," with special reference to pulverized coal and fuel oil.

The American Institute of Electrical Engineers will hold its Pacific Coast convention this year at Los Angeles, Calif., Sept. 18 to 20 inclusive. The convention will be held under the auspices of the local section, and it is expected that John P Fisken., one of the institute's vice-presidents will preside at the various meetings. A tentative program has been worked up and includes the following papers: "Order and Amplitude of Harmonics in Voltage-Wave Forms with Indicating Instruments," by Leslie F. Curtis; "Theory of Probabilities Applied to Failures of Suspension Insulators," by L. M. Klauber; "Predetermination of Synchronous Phase-Modifier Performance," by Hubert V. Carpenter. "Operating Features of a 1000-Mile, 220,000-volt Transmission Line," by R. W. Sorrenson, H. H. Cox and G. E. Armstrong.

Personals

C. Lincoln Smith, who in the past has been sales engineer for the Sanford Riley Stoker Co. and the Murphy Iron Works in the Chicago territory has been transferred to the company's Pittsburgh office.

R. S. Rowe, formerly western representative of the Lunkenheimer Co., with offices in Denver and Minneapolis, has been appointed export manager with office in New York City.

W. E. Symons and R. Sanford Riley have been appointed by the Council of the American Society of Mechanical Engineers to represent the society in the celebration of the centenary of the death of James Watt, at Birmingham, England.

Byron F. Stowell, for many years connected with the Hendee Manufacturing Co., Springfield, Mass., as master mechanic and mechanical engineer, has resigned to accept a position with the Napier Saw Works, Inc., of same city.

Obituary

William V. R. Coon, for many years a member of Ohio No. 37, N. A. S. E., of Dayton, died of cancer of the stomach on July 26. Mr. Coon was one of the best and most favorably known engineers in this part of the country. As a delegate from Ohio No. 37, he had attended nearly all National conventions for the past 20 year.. He served as secretary of the State Association for three years, and as corresponding secretary of No. 37 for fifteen years He was also affiliated with the Craftsmen the Woodmen, the Junior Order of American Mechanics, the Sons of Veterans, and was a 32rd degree Mason. For many years he was chief engineer of Lowe Brothers steam plant; later he was state examiner of engineers for three years, and for a like period he was chief engineer of the Dayton City Water Works.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7 95
Stove	7.95@8 15
Chestnut	8.05@8 35

Bituminous

	Clearfields	Cambrias and Somersets
F. o. b. mines, net tons	$2.60@3.10	$3.00@3.60
F. o. b. Philadelphia, gross tons	4.79@5.35	5.20@5.80
F. o. b. New York, gross tons	5 10@5.70	5.50@6.20
Alongside Boston (water coal), gross tons	6.85@7.35	7.10@7.85

Georges Creek is quoted at $3.70 per net ton, f. o. b. mines.

Pocahontas and New River are being quoted at $6.25@6.60 per gross ton f.o.b. Norfolk and Newport News, Va., in response to export demand. There are practically no sales for coastwise shipment.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5 95	$7.80	Pea	$5.20	$6.95
Egg	6 25	8.10	Buckwheat	3.40	5 15
Stove	6.50	8.35	Rice	2 75	4 50
Chestnut	6.60	8.45	Barley	2.25	4.00

Bituminous

Current quotations on spot coal, net tons, at the mines average about as follows:

	Spot
South Fork (best)	$3.25@3.50
Cambria (best)	3.00@3.25
Cambria (ordinary)	2.65@2.90
Clearfield (best)	3.00@3.25
Clearfield (ordinary)	2.70@3.00
Reynoldsville	2.70@2.90
Quemahoning	3.10@3.25
Somerset (best)	3.00@3.25
Somerset (poor)	2.65@2.75
Western Maryland	2.50@2.75
Fairmont	2.10@2.35
Latrobe	2.60@2.65
Greensburg	2.50@2.60
Westmoreland ¾ in.	2.75@2.90
Westmoreland run-of-mine	2.50@2.60

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide	Anthracite	Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	6.25	8.10	Rice	2.75	3.65
Stove	6.50	8.35	Boiler	2.50	3.50
Nut	6.60	8.45	Barley	2.25	3.15
Pea	5.20	6.80			

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3.25
Mine-run	2 35@ 2.50	3.00
Screenings	1.40@ 1 60	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.45	$2.75	$2.40
Black Creek and Cahaba	3.45	3.75	3.05
Jagger - Pratt Corona	2.85	3.05	2.45
Blacksmith	....	5.25	.....

Domestic quotations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3.95@$4.60
Corona	3.50
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

Franklin County		Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$2.85*@3.05	$2.55	$2.25@2.50
Mine run	2 10*@2.35	2.35	1.60@1.70
Screenings	1.50*@2 20	2.05	.90@1.00

* Indicates prices on independent coal.

Williamson-Franklin rate to St. Louis is $1 07½; other rates $0.92½.

New Construction

PROPOSED WORK

N. H., Portsmouth—Spec. No. 4017—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to install a 1000 k.w. turbo-generator, here. Estimated cost, $17,000.

Mass., Pittsfield—The city received low bid for the construction of a school house on Wahconah St. in Pontoonac District from E. C. Corlson & Co., 310 Main St., Springfield. A heating system will be installed in same. Total estimated cost, $129,600.

R. I., North Smithfield—The Andrews Mills Co., Branch Village, plans to install 2600 ft. c. i. waterpiping in its proposed 40 x 40 ft. reinforced concrete pump house, and a 250 hp. wheel in its proposed concrete power house. Work will be done by day labor. Jenks & Ballou, 1035 Grosvenor Bldg., Providence, Engr.

Conn., Bridgeport—The Bridgeport Brass Co., Grand St., will build a 1 story, 150 x 220 ft. addition to its casting shop on Grand St. Electric power to operate crane will be installed in same. Is in the market for Shepherd electric crane. Total estimated cost, $150,000. The H. M. Lane Co., 701 Owen Bldg., Detroit, Engr.

Conn., Hartford—The American School for the Deaf, 65 Garden St., will soon award the contract for the construction of 3 buildings for a school. A steam heating system will be installed in same. Total estimated cost, $500,000. Boring and Tilton, 52 Vanderbilt Ave., New York City, Engr.

Conn., Litchfield — The St. Michael's Protestant Episcopal Society will soon receive bids for the construction of a church on Main St. A steam heating system will be installed in same. Total estimated cost, $100,000. Rossiter & Muller, 15 West 38th St., New York City, Arch.

Conn., Mystic—The Packer Tar Soap Co., Lincoln Ave., plans to build a 1 story storage building, a 1 story factory, and a 25 x 30 ft. power house. A steam heating system will be installed in same. Total estimated cost, $40,000. Bilderbeck & Langdon, Inc., Barrows Bldg., New London, Engr.

Conn., New Haven—J. A. Wetmore, Supervising Arch., Treasury Dept., Wash., D. C., will receive bids Sept. 12, for a motor driven triplex pump for the U. S. Post-Office here.

N. Y., Albany—The Kelley Dennin Co. plans to build garage, machine shop and salesroom on Broadway, to be 1 story, 150 x 150 ft. with 2 wings. A steam heating plant will be installed in same. Total estimated cost, $150,000. A. E. Lew, Vice Pres.

N. Y., Bronklyn—Magid, Katzman & Strober, 58 Boerum St., plan to construct a 1 story, 100 x 185 ft., warehouse garage and workshop on Jefferson St., Wyckoff and Flushing Ave. A steam heating system will be installed in same. Total estimated cost, 120,000. H. J. Nurick, 957 Broadway, Eng.

N. Y., Brooklyn—The Weber Realty Co., 520 St. Mark's Ave., plans to construct a 1 story, 145 x 185 ft., theatre on St. Johns Pl., near Kingston Ave. A steam heating system will be installed in same. Work will be done by day labor. Total estimated cost, $230,000.

N. Y., Buffalo—W. F. McDonald, 577 Cambridge St., plans to erect a brick and concrete theatre on Hertel Ave., between North Park and Norwalk Ave. A steam heating and ventilating system will be installed in same. Total estimated cost, $220,000.

N. Y., Champlain—The Champlain Power Co. is repairing its plant and is in the market for new machinery.

N. Y., Geneva—Board of Public Works is in the market for a centrifugal pump, 4 million gallon per day capacity. J. W. Brennan, City Engr.

N. Y., Geneva—The O'Malley Motor Co. plans to build a 3 story, 50 x 100 ft. machine shop, garage and service station, on Canal and Exchange Sts., and will install transmission and electric power in same. Total estimated cost, $50,000.

N. Y., Long Island City—Louis Geld, 44 Court St., Brooklyn, will build a 5 story, 100 x 175 ft. garage on 7th and Pierce Ave. and a 1 story, 95 x 235 ft. factory, on Harris and Van Alst Ave. Steam heating systems will be installed in same. Total estimated cost, $220,000 and $150,000 respectively. Work will be done by day labor

N. Y., New York—Spec. No. 4016—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to install a turbo-air compressor, here. Estimated cost, $60,000.

N. Y., New York—The Department of Health plans to construct a 10 story, 100 x 100 ft. laboratory and office building at 136 West 30th St. A steam heating system will be installed in same. Total estimated cost, $700,000. R. S. Copeland, Supt. C. B. Myers, 1 Union Square, Arch.

N. Y., New York—The International Tailoring Co., 97 East Houston St., had preliminary plans prepared for a 12 story, 116 x 142 ft. office building on 4th Ave. and 12th St. A steam heating system will be installed in same. Total estimated cost, $750,000. Starrett & Van Vleck, 8 West 40th St., Engr.

N. Y., New York—The Krim Realty Co., 426 West 14th St., plans to construct a 3 story, 25 x 100 ft. store and office building at 143 West 33rd St. A steam heating sytem will be installed in same. Total estimated cost, $100,000.

N. Y., New York—The Port Morris Holding Co., c/o Winter & Co., 137th St. and Southern Boulevard, is having plans prepared for the construction of a 6 story, 375 x 382 x 316 x 390 ft. piano factory, on 141st St. and Walton Ave. A steam heating system will be installed in same. Total estimated cost, $500,000. Ballinger & Perrott, 47 West 34th St., Engr.

N. Y., New York—N. Reinhardt, 972 Brook Ave., Bronx, will receive bids until September 1st for the construction of a 6 story, 100 x 120 ft. ice plant on Bedford Park Blvd. Estimated cost, $150,000. M. Haulse, 3307 3rd Ave., Engr.

N. Y., New York—The 60 West 68th St. Corporation, Inc., 300 8th Ave., will build an 11 story, 80 x 85 ft. hotel, at 60-66 West 68th St. A steam heating system will be installed in same. Work will be done by day labor. Total estimated cost, $450,000.

N. Y., New York—Starrett & Van Vleck, Arch., 8 West 40th St., preparing plans for a 15 story, 80 x 115 ft. hotel to be erected on 72nd St. and West End Ave. A steam heating system will be installed in same. Total estimated cost, $1,000,000. Owner's name withheld.

N. Y., New York—The 305 West End Corporation, 200 West 72nd St., is having plans prepared for a 14 story, 100 x 143 ft. hotel, at 301-303 West End Ave. A steam heating system will be installed in same. Total estimated cost, $400,000. Schwartz & Gross, 347 5th Ave., Arch.

N. Y., New York—The 30 West 59th St. Incorporation, 120 Broadway, is having plans prepared for a 14 story, 50 x 80 ft. hotel, at 30 West 59th St. A steam heating system will be installed in same. Total estimated cost, $450,000. J. E. R. Carpenter, 681 5th Ave., Engr.

N. Y., New York—Warren & Wetmore, Arch., 16 East 47th St., will soon award the contract for the construction of a 180 x 200 ft. hotel, on Park Ave. and 51st St., for D. M. Linard, c/o architect. A steam heating system will be installed in same. Total estimated cost, $7,500,000. H. Balcom, 10 East 47th St., Engr.

N. Y., Norfolk—The Remington Paper and Power Co., Sherman Bldg., Watertown, plans to replace steam engine and transmission destroyed by bursting 14 ft. flywheel. Estimated cost, $20,000.

N. Y., Norwich—The city is having plans prepared for the construction of a library. A steam heating system will be installed in same. Total estimated cost, $125,000. Tooker & Marsh, 101 Park Ave., New York City, Engr. and Arch.

N. Y., Portchester—The Mint Products Co., c/o Lockwood, Greene & Co., Arch., 101 Park Ave., New York City, plans to construct a 4 story, 80 x 200 ft. factory. A steam heating system will be installed in same. Total estimated cost, $250,000.

N. Y., Poughkeepsie—Otto Wolpert, Arch. and Engr., 63 Park Row, will soon award the contract for the construction of a 1 story, 80 x 140 ft. threading machine factory on Fulton St. A steam heating system will be installed in same. Total estimated cost, $500,000. Owner's name withheld.

N. Y., Syracuse—The Great Northern Warehouse, Inc., plans to construct a 7 story, 150 x 200 ft. warehouse on West Fayette St. A steam heating system will be installed in same. Total estimated cost, $400,000. Thompson & Binger, Gurney Bldg., Engr.

N. Y., Syracuse—The H. H. Franklin Co., 302 South Geddes St., will install a steam heating system, two 600 h.p. boilers and automatic stokers in its new 60 x 140 ft. factory. Total estimated cost, $250,000. S. Firestone, Granite Bldg., Rochester, Engr.

N. Y., Taleville—The St. Lawrence Transmission Co., Massena, F. A. Stoughton, Pres., has purchased the rights of A. J. McDonald in the Freeman Talc Mine, near here, and plans extensive improvements and installation of crushing and conveying machinery and electrical driven units. Estimated cost, between $50,000 and $60,000.

N. Y., Waterloo—The Waterloo Wagon Co. plans to install machine tools, electric power drive and transmission. Estimated cost, between $12,000 and $15,000.

N. J., Bayonne—The Board of Directors of Bayonne City Hospital plans to build an addition to hospital, and erect a power plant and nurses' home. Total estimated cost, $250,000. Randolph Sluter, 79 West 41st St. and J H. Mahken, 229 Broadway, are members of committee.

N. J., North Bergen—J. A. Migel, Inc., 442 4th Ave., New York City, will soon award contract for the construction of a mill, on Hudson Boulevard, here. A steam heating system will be installed in same. Total estimated cost, $500,000. Seabury-Dwight, 12 East Ave., Pawtucket, R. I., Engr. and Arch.

Penn., Carlisle—C. H. Masland & Sons, Inc., Amber and Westmoreland St., Philadelphia, is in the market for engines, piping and boilers for new power house which is to be built here in connection with mill. J. S. Rogers Co., Drexel Bldg., Philadelphia, Arch.

Penn., Hazelton—The Board of Education will soon award the contract for the construction of a 2 story, 60 x 300 ft. high school on Church St. A steam heating system will be installed in same. Total estimated cost, $250,000. D. A. Harmon, Hazleton, Arch.

Penn., McKeesport, Cristy Park—The National Tube Co., Frick Bldg., is receiving bids for constructing a 3 story, 46 x 90 ft. office building and a 3 story 47 x 64 ft. time building. Steam heating system reduction from high to low pressure, will be installed in same. Edward Stotz, Monongahela Bank Bldg., Arch.

Penn., Philadelphia—The Bureau of Water Supply, 792 City Hall, will receive bids until September 2 for 4 turbo-centrifugal pumps for the Queen Lane section.

Penn., Philadelphia—The Children's Hospital, 18th and Bainbridge St., plans to install a new power plant and boilers in the proposed addition. Address A. Harrison, Ch. Engr.

Penn., Philadelphia — The Comery Schwartz Motor Car Co., 128 North Broad St., plans to construct a 6 story, 210 x 440 ft. building at 24 Market St. A steam heating system will be installed in same. C. E. Oelschlager, 1615 Walnut St., Arch.

Penn., Philadelphia—The Department of Health & Charities plans to alter and enlarge, also construct new buildings at the Philadelphia Hospital for Contagiuos Diseases. A steam heating system will be installed in same. Total estimated cost, $300,000. Philip H. Johnson, 1713 Sansom St., Engr.

Penn., Philadelphia—The Methodist Episcopal Hospital, Broad and Wolf St., has had plans prepared for a 5 story, 80 x 125 ft. hospital on Broad and Ritner St. A steam heating system will be installed in same. Horace W. Castor, 21 South 12th St., Arch.

Penn., Pittsburgh—The Board of Education plans to construct a 4 story addition to South Hills High School, on Ruth St. A steam heating system, ventilating fan and low pressure boilers will be installed in same. Total estimated cost, $911,200. Alden & Harlow, Farmers' Bank Bldg., Arch.

Penn., West Bethlehem—The Board of Education will soon award the contract for the construction of a 2 story, 176 x 185 ft. school building. A steam heating system will be installed in same. Total estimated cost, $200,000. Ritter & Shay, North American Bldg., Philadelphia, Arch.

Penn., Wilkes-Barre—The city plans to build a 3 story, 63 x 276 ft. high school, with 75 x 75 ft. wing, on Grant and Sherman St. A steam heating system will be installed in same. Total estimated cost, $400,000. Robert Ireland, North Washington St., Engr.

Md., Baltimore—The Century Theatre Co., Inc., c/o C. E. Whitehurst, pres., Park Ave. and Lexington St., plans to construct a 2 story, 120 x 178 ft. theatre at 18 West Lexington St. Steam heating, electric lighting, air cooling and refrigerating systems will be installed in same. Total estimated cost, $750,000. J. J. Ziuk, 213 West Calvert St., Arch.

Md., Baltimore—F. A. Furst, Pres., Furst-Clark Construction Co., 1515 Fidelity Bldg., and other capitalists and financiers plan to build heating plant and substation in connection with development of 200 acre tract, from Spring Gardens to Fort McHenry Baltimore Southwest Channel Harbor, for system of docks and warehouses. Estimated cost, $175,000. F. W. Kesselbaum. c/o Baltimore Dry Dock & Ship Building Co., Locust Point, Engr.

Md., Baltimore—Hutzler Bros. Co., 212 North Howard St., plans to build an 8-story, 60 x 154x 60 ft. warehouse at Saratoga and State Sts. A steam heating system will be installed in same. Total estimated cost, $85,000. Frank Baldwin, 328 North Charles St., Arch.

Va., Ivor—The Ivor Light and Power Co., recently incorporated, plans to equip a plant for furnishing light and power in town and vicinity. T. A. Saunders, Pres.

Ohio, Cleveland—Allen Bros., Toronto, Canada, c/o A. M. Allen Co., Arch., 1900 Euclid Ave., are having plans prepared for a 10 story, 150 x 225 ft. theatre and commercial building to be erected on East 14th St. and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $175,000.

Ohio, Cleveland—The Board of Education, East 6th St. and Rockwell Ave., is having preliminary plans prepared for the construction of a 2 story, 80 x 120 ft. high school addition on East 55th St. and Scoville Ave. A steam heating sytem will be installed in same. Total estimated cost, $150,000. W. R. McCormack, East 6th St. and Rockwell Ave., Arch.

Ohio, Cleveland—The Brown Fence & Wire Co., 6532 Juanita Ave., plans to construct a 3 story, 100 x 180 ft. warehouse. A steam heating system will be installed in same. Total estimated cost, $125,000.

Ohio, Cleveland—The Chandler Motor Car Co., East 131st St. and St. Clair Ave., plans to build a 5 story, 42 x 95 ft. office building on East 131st St. and St. Clair Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—The Colburn Machine Tool Co., 1041 Ivanhoe Rd., plans to build a 1 story, 192 x 238 ft. factory at 1040 Ivanhoe Rd. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—The Corday & Gross Co., 113 St. Clair Ave., plans to construct a 2 story, 135 x 200 ft. factory and print shop on East 24th St. and Chester Ave. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ohio, Cleveland—The Crown Land Co., East 22nd St. and Superior Ave., plans to build a 6 story, 107 x 125 ft. factory, on West 3rd St. and Lakeside Ave. A steam heating system will be installed in same. Total estimated cost, $200,000.

Ohio, Cleveland—The Eveland Theatre Co., Hippodrome Bldg., plans to build a 10 story, 150 x 200 ft. theatre and office building, on East 7th St. and Prospect Ave. A steam heating system will be installed in same. Total estimated cost, $1,500,000.

Ohio, Cleveland—Joseph Laronge, 214 Williamson Bldg., plans to build a 10 story, 160 x 188 ft. theatre and office building on East 14th St. and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $3,000,000. T. W. Lamb, 644 8th Ave., New York City, Arch.

Ohio, Cleveland—Joseph Laronge, 214 Williamson Bldg., plans to erect a 6 story, 80 x 140 ft., commercial building on East 55th St. and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $150,000.

Ohio, Cleveland—The National Lamp Works, Nela Park, plan to build a 2 story, 64 x 139 ft. service building at Nela Park. A steam heating system will be installed in same. Total estimated cost, $150,000. Frank E. Willis, 56 West 45th St., New York City, Engr.

Ohio, Cleveland—The W. M. Pattison Co., 777 Rockwell Ave., is having plans prepared for a 4 story, 161 x 192 ft. addition to its factory, at 9205 Detroit Ave. A steam heating system will be installed in same. Total estimated cost, $100,000. The Osborn Engineering Co., 2848 Prospect Ave., Engr.

Ohio, Cleveland—Louis A. Skeel, 1040 Forest Cliff Drive, plans to construct a 5 story, 50 x 189 ft., commercial building at 2044 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—Schwartz, Forney & Hexter Co., West 6th & Lakeside Ave., plans to build a 5 story, 100 x 150 ft. factory, on East 30th St. and Superior Ave. A steam heating system will be installed in same. Total estimated cost, $250,000.

Ohio, Columbus—The Children's Hospital Association, Fair Ave. and Franklin Park West, plans to construct a 4 story, 40 x 200 ft. hospital with two wings, one 40 x 150 ft. and the other 25 x 60 ft., on 17th St. A steam heating sytem will be installed in same. Total estimated cost, $300,000. Richards, McCarty & Bulford, 584 East Broad St., Arch.

Ohio, Cleveland—The Vlchek Tool Co., Mount Auburn St., is having plans prepared for a 1 story, 96 x 256 ft. factory addition, at 871 Mount Auburn St. A steam heating system will be installed in same. Total estimated cost, $100,000. G. S. Rider Co., Century Bldg., Arch.

Ohio, Dayton—The Gem City Ice Cream Co., 1005 West 3rd St., plans to enlarge its plant, and will install a 180-ton Hardwick ice machine and new electrical motors.

Ohio, Dayton — The National Military Home will soon award contract for the furnishing of one duplex Smith-Vaile pump, 5,000,000 gallon, 24" x 36" x 18"; two 125 h.p. R. T. Brownell boilers; three 100 h.p. open heaters; valves, piston rods, water plunger, etc. J. E. Gimperling, Quartermaster.

Mich., Detroit—The Board of Education, 50 Broadway Ave., is having tentative plans prepared for a high school, junior high school and elementary school, on Linwood, Webb and Collingwood Ave. Combined system or plenum system of heating will be installed. Total estimated cost, $1,000,000. Malcolmson & Higginbotham, 404 Moffat Bldg., Arch.

Mich., Detroit—The Board of Education, 50 Broadway, will soon award the contract for the construction of G. M. Condon School, on Buchanan and Vinewood Ave., 2 story, 110 x 130 ft., and the Nichols School, on Burns and Goethe Ave., 2 story, 78 x 105 ft. Separate boiler and fuel room, including boiler, fan, plenum heating system, etc., will be installed in same.

Mich., Detroit—C. W. Brandt, Arch., 1114 Kresge Bldg., plans to build a 2 story, 100 x 160 ft. theatre on Woodward Ave. A steam heating plant, boiler, fans and air washer, will be installed in same. Total estimated cost, $150,000. Owner's name withheld.

Mich., Detroit—D. L. Calwell, 701 Old Whitney Bldg., is having plans prepared for the construction of a 3 story, 150 x 160 ft. mercantile building, on Grand River Ave., near Hobson St. A steam heating system will be installed in same. Total estimated cost, $100,000. Williams Bros., 1111 Kresge Bldg., Arch.

Mich., Detroit—The City Water Commission, 232 Jefferson Ave., received bids for the construction of roof trusses and roof complete over engine room and pumping statin, building 67 x 307 ft., span of trusses 67 ft. from The Wisconsin Bridge and Iron Co., 1362 Penobscot Bldg., $62,000; Culbertson & Kelly, 814 Ford Bldg., $70,997, and Whitehead & Kales, Beecher St. and Michigan Central Ry., $84,365.

Mich., Detroit—Robert Finn, Arch., 435 Woodward Ave., is preparing plans for the construction of a 3 story, 70 x 110 ft. factory, on Riopelle and Winder St. A steam heating equipment, consisting of boiler and accessories, also motors for power, will be installed in same. Total estimated cost, $35,000. Owner's name withheld.

Mich., Detroit—Mildner & Eisen, 924 Hammond Bldg., Archs., are receiving bids for the building of a 2 story 75 x 130 ft. machine shop and office on Fourth and Porter St., for the Mutual Electric & Machine Co., 232 Fort St. A steam heating system will he installed, power to be furnished by electric motors.

Mich., Detroit—C. E. Rogers, 3 Goldsmith St., is having plans prepared for a 1 story, 100 x 214 ft. factory, on West Fort St. A steam heating system and electric motors for power will be installed in same. Total estimated cost, $80,000. Varney & Varney, 307 Palmer Bldg., Arch.

Mich., Detroit—The Westminster Presbyterian Church, Woodward and Parsons St., plans to build a 2 story, 114 x 118 ft. community house at Glynn Court and Hamilton Boulevard. A steam heating plant, consisting of boiler and accessories, will be installed in same. Total estimated cost, $100.000. G. M. Lindsey, 2201 Dime Bank Bldg., Arch.

Mich., Flint—The Flint Regent Theatre Co., Saginaw St., is receiving bids for a 1 story, 50 x 90 ft. theatre at Louisa and Saginaw St. A steam heating system will be installed in same. Total estimated cost $100,000.

Mich., Grand Rapids—St. Joseph Seminary, Boston St., is having plans prepared for the construction of a 3 story, 90 x 200 ft. seminary on Boston St. and Union Ave. A steam boiler, pump and accessories, will be installed in same. Total estimated cost, $200,000. Spier & Gehrke, 1317 Chamber of Commerce Bldg., Detroit, Arch.

Mich., Three Rivers—The Eddy Paper Co. has had plans prepared for the construction of a 50 x 100 ft. power plant on Michigan St. Five 300 h.p. vertical Wicks water tube boilers will be installed in same. Billingham & Cobb, Kalamazoo, Arch.

Mich., Wyandotte—Wyandotte Lodge, F. & A. M., is having plans prepared for a 3 story, 75 x 120 ft., Masonic Temple on Biddle Ave. A steam heating sytem will be installed in same. Total estimated cost, $115,000. G. W. Graves, 43 John R. St., Detroit, Arch.

Ill., Chicago—G. J. Breinig, of Rockford, c/o Henry J. Schlacks, Arch., 721 North Michigan Ave., is having plans prepared for a 2 story, 140 x 200 ft. dance hall to be erected on Grace St. near Broadway. A steam heating system will be installed in same. Total estimated cost, $150,000.

Ill., Chicago—The H. Channon Co., 150 North Market St., is having plans prepared for a 7 story, 120 x 180 ft. warehouse, on Randolph and Market St. A steam heating system will be installed in same. Total estimated cost, $400,000. Alfred S. Alschuler, 28 East Jackson St., Arch.

Ill., Chicago—The Fulton Market Cold Storage Co., c/o Gardner & Lindberg, Engr., 38 South Dearborn St., has had plans prepared and will soon receive bids for a 10 story, cold storage warehouse, on Fulton and Morgan St. Total estimated cost, $4,000,000.

Ill., Chicago—Z. E. Smith, Arch., 5501 Prairie Ave., will soon award the contract for a 4 story, 60 x 125 ft. factory and office building, on State St. and 36th Pl., for the Overton Hygienic Mfg. Co., 5200 South Wabash Ave. A steam heating system will be installed in same. Total estimated cost, $125,000.

Ill., Chicago—The Sheridan-Wilson Hotel Co., c/o W. W. Ahlschlager, Arch., 111 West Washington St., is having plans prepared for a 12 story, 130 x 225 ft. hotel on Sheridan Road and Wilson Ave. A steam heating system will be installed in same. Total estimated cost, $2,000,000.

Ill., Chicago—The Wilson-Jones Loose Leaf Co., 3021 Carrol Ave., plans to build a 2 story, 250 x 400 ft. factory, on Ohio St. and Spaulding Ave., to include power plant and garage. Total estimated cost, $100,000.

Wis., Janesville—The Bower City Bank, Main and East Milwaukee St., is having plans prepared by Childs & Smith, Arch., 64 East Van Buren St., Chicago, for the construction of a 6 story, 50 x 125 ft. bank and office building. A steam heating system will be installed in same. Total estimated cost, $200,000.

Wis., Peshtigo—The Peshtigo Paper Co. is receiving bids for furnishing motors and two 75 h.p. variable speed engines, etc. L. A. DeGuerre, Grand Rapids, Mich., Engr. Noted Aug. 5.

Wis., Superior—The city will receive bids September 11, for the building of a 3 story, 102 x 140 ft. auditorium, on Ogden Ave. and 14th St. Steam heating and ventilating systems will be installed. Total estimated cost, $150,000. J. O. Bach, 1111 Tower Ave., Engr.

Iowa, Davenport—Henry C. Kahl, c/o Walsh-Kahl Construction Co., is having plans prepared for the construction of a 10 story, 145 x 150 ft. theatre and office building on 3rd and Ripley Sts. A steam heating system will be installed in same. Total estimated cost, $1,000,000.

Ia., Dexter—The Town Council will soon receive bids for one 15 h.p. oil engine or motor, one 200 gal. per minute pump and one 12 x 16 ft. brick pump house in connection with its water distributing system.

Ia., Spencer—E. C. Tangney, Sheldon, is having plans prepared for a 4 story hotel here. A steam heating system will be installed in same. Total estimated cost, $100,000. Boyd & Moore, 314 Securities Bldg., Des Moines, Arch.

Iowa, Winterset—Board of Education will build a 2 story, 90 x 140 ft. school. A steam heating system will be installed in same. Total esitmated cost, $150,000. W. E. Hulse & Co., Hutchinson, Kan., Arch.

Minn., Alexandria—The county commissioners of Douglas County are in the market for 1 grain loading apparatus with bin, and one 8 to 12 h.p. engine. Vernon Thomas, County Auditor.

Minn., Chisholm—Town will build a 2 story, 100 x 175 ft. recreation building on Main St. A steam heating and mechanical ventilating system will be installed in same. Total estimated cost, $200,000.

Minn., Hastings—The State Board of Control, St. Paul, will receive bids until September 1 for the construction of a 1 story, 45 x 140 ft. power plant, here. Total estimated cost, $125,000. O. H. Johnston, Capital Bank Bldg., St. Paul, Engr.

Minn., Montevideo—W. E. Skinner, Engr., received bids for extending waterworks system, including one 750 gal. per minute centrifugal pump with motor, switchboard and piping, etc., from W. D. Lovell, 2247 Hendon Ave., Minneapolis, $5621. Noted July 29.

Minn., St. Paul—The City Board of Water Commissioners plans improvements to cover a period of five years, to include conduit from Lake Vadnais to city, capacity 65,000,000 gals. each 24 hours, estimated cost, $440,000; low service main from Cayuga St. to congested district and new pumps, estimated cost, $300,000; impounding reservoir, 10,000,000,000 gals., estimated cost, $525,000; reservoir on Snelling Ave. near Otto St., $160,000.

Kan., Arkansas City—Arkansas Hotel Co. plans to construct a 3 story hotel. A steam heating system will be installed in same. Total estimated cost, $200,000. Shepard, Faurer & Wise, R. A. Long Bldg., Kansas City, Mo., Arch.

Kan., Arlington—The city voted $20,000 bonds to build an electric transmission line.

Kan., Chanute—The city voted $250,000 bonds for the construction of an electric light plant.

Kan., Emporia—The Citizens' National Bank is having preliminary plans prepared for a 7 story, 62 x 130 ft. bank. A steam heating system will be installed in same. Total estimated cost, $350,000. Weary & Alford, 1907 South Michigan Ave., Chicago, Arch.

Kan., Holton—Jackson County will build a 3 story, 85 x 100 ft. court house. A steam heating system will be installed in same. Total estimated cost, $140,000. W. Wiliamson & Co., Topeka, Arch.

Kan., Independence—The Commercial National Bank is having plans prepared for a 6 story, 70 x 140 ft. bank and office building. A steam heating system will be installed in same. Total estimated cost, $150,000. G. T. Guernsey, Pres. Weary & Alford, 1907 South Michigan Ave., Chicago, Arch.

Kan., Lyndon—Osage County will receive bids Sept. 4 for the construction of a 3 story court house. A steam heating system will be installed in same. Total estimated cost, $200,000. W. E. Hulse & Co., Hutchison, Arch.

Kan., Partridge—The city voted $20,000 bonds to build an electric transmission line.

Kan., Peabody—The F. P. Steinhauer Association is having plans prepared for a 3 story, 50 x 140 ft. hotel, to be known as the Hotel Forrester. A steam heating system will be installed in same. Total estimated cost, $100,000. D. B. Foster and J. H. Felt & Co., 802 Grand Ave. Temple, Kansas City, Mo., Arch.

Kan., Wichita—The Board of Education will receive bids about Sept. 2 for the construction of Mark Twain School, 3 story. A steam heating system will be installed in same. Total estimated cost, $250,000. H. A. Noble, Kansas City, Mo., Engr.

Kan., Wichita—The State Savings & Mercantile Bank, 115 East Douglas Ave., is having plans prepared for the construction of a 4 story, 55 x 140 ft. bank. A steam heating system will be installed in same. Total estimated cost, $150,000. Childs & Smith, 64 East Van Buren Ave., Chicago, Ill., Arch.

Neb., Blue Springs—The Board of Education is receiving bids for the construction of a 3 story, 100 x 140 ft. school. A steam heating system will be installed in same. Total estimated cost, $150,000. W. E. Hulse & Co., Hutchinson, Kan., Arch.

Neb., Lincoln—The Board of Education is having preliminary plans prepared for the construction of a 2 story school on 22nd and Lake Sts. A steam heating system will be installed in same. Total estimated cost, $450,000. Fiske & Meginnis, 533 Bankers Life Bldg., Arch.

Neb., Mead—The Board of Education c/o Fred Behrens, Chn., is having plans prepared for the construction of a 2 story, 80 x 130 ft. school. A steam heating system will be installed in same. Total estimated cost, $130,000. Ellery Davis, 1809 South St., Lincoln, Arch.

Neb., Omaha—M. E. Smith & Co., Kennedy Bldg., plans to build an 8 story, 100 x 132 ft. factory on 10th and Douglas Sts. A steam heating system will be installed in same. Total estimated cost, between $350,000 and $400,000. F. S. Scott, Kennedy Bldg., Arch.

Neb., Winnebago—Board of Education. Sioux Falls, S. D., will soon award the contract for the construction of a 2 story, 65 x 130 ft., grade school. A steam heating system will be installed in same. Total estimated cost, $100,000. Holmes & Flinn, 8 South Dearborn St., Chicago, Ill., Arch.

S. D., Bruce—The city will receive bids Sept. 5 for a 1750 hp. motor and a motor driven pump, 350 gal. per minute. L. P. Wolff, Guardian Life Bldg., St. Paul, Minn., Engr.

N. D., Maddock—The city will soon award the contract for the installation of an electric unit, including engine, generator, switchboard and necessary appurtenances.

Mo., Maryville—The city will receive bids Sept. 2 for the construction of two reservoirs, coagulatory plant, storage basin, two 600 g.p.m. motor driven pumps and one 7000 g.p.m. low service pump. Estimated cost, $35,000. E. E. Harper, 2408 East 30th St., Kansas City, Engr.

Okla., Okmulgee—L. H. D. Cook will receive bids Sept. 2 for the construction of a 2 story, 50 x 140 ft. theatre. A steam heating system will be installed in same. Total estimated cost, $100,000. Smith Rea, Lovitt & Senter, Okmulgee, Arch.

Cal., Los Angeles—The Board of Public Works will receive bids until Sept. 2 for furnishing sewage pumping equipment for the Manchester Ave. sewage pumping plant. Estimated cost, $6000. A. C. Hansen, City Engr.

N. S., Berwick—The Water Commissioners will receive bids until Aug. 30 for the construction of a concrete and timber dam, power house and wheel pit, including 1 15-in. diameter water turbine under 80 in. head. Total estimated cost, $27,500. S. E. March, Berwick, Engr.

CONTRACTS AWARDED

Mass., Pittsfield—The Common Council has awarded the contract for the construction of a 10 story schoolhouse, near present Pontassic school, to the Ernest & Carlson Co., 310 Main St., Springfield. A heating and ventilating system will be installed in same. Total estimated cost, $170,000.

R. I., Providence—The Rhode Island School of Design, Waterman St., has awarded the contract for the construction of a 4 story, 58 x 82 ft. jewelry building on Bene St., to C. B. Maguire Co., 1206 Turks Hero Bldg. A steam heating system will be installed in same. Total estimated cost, $125,000.

Conn., Danbury—The Standard Oil Co., Shelter Rock Rd., has awarded the contract for constructing 1 story pump house, 1 story, 11 x 45 ft. heater building and 1 story, 30 x 45 ft. garage, to the R. W. Smith Construction Co., 638 Lexington Ave. Total estimated cost, $22,000.

Conn., Forestville—The Peck & Young Manufacturing Co., Stratford Ave., has awarded the contract for the construction of a 1 story, 60 x 200 ft. factory, 1 story, 40 x 80 ft. garage and a 1 story, 25 x 35 boiler house, to the J. H. Grozier Co., 756 Main St., Hartford. Steam heating system will be installed in same. Total estimated cost, $50,000.

Conn., Hartford—The city has awarded the contract for the construction of a central heating plant, to take care of the public market and proposed new bath house, to the Ahern & Welch Co., 721 Main St. Estimated cost, $21,000. Noted May 13.

Conn., Hartford—The Hartford Times, 716 Main St., has awarded the contract for the construction of a 3 story office building on Prospect St., to Marc Eidlitz, 30 East 42nd St., New York City. A steam heating system will be installed in same. Total estimated cost, $100,000.

Conn., Plainville—Neri Brothers, 8 East Main St., has awarded the contract for the construction of a 3 story, 60 x 124 ft. brick business building on Main St., to Angelo Berti, 138 Oak St., New Britain. A steam heating apparatus will be installed in same. Total estimated cost, $100,000.

Conn., Waterbury—The Scovill Mfg. Co., 99 Mill St., has awarded the contract for the construction of a 4 story office building on Cole, Baldwin and Mills St., to Marc Eidlitz & Sons Co., 30 East 42nd St., New York City. A steam heating system will be installed in same. Total estimated cost, $150,000.

N. Y., Central Islip—The State Hospital Commission, Albany, has awarded the contract for installing new boilers, stokers, etc., in new central heating and lighting plant for the state hospital here, to Chute, Thornton & Bayley Corporation, 2 East 13th St., New York City. Estimated cost, $81,600. Noted Feb. 4.

N. Y., Gouverneur—The Board of Education has awarded the contract for the installation of a new heating and ventilating system in the Gouveneur High School, to the Ryan Plumbing Co., Light & Power Bldg., Watertown. Estimated cost, $24,000. Noted July 22.

N. Y., Long Island City—The American Chicle Co., 19 West 44th St., New York City, has awarded the contract for constructing a 6 story, 200 x 600 ft. factory at Degnal Terminal, to the Turner Construction Co., 244 Madison Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $2,000,000.

N. Y., Long Island City—L. J. Selznick, 729 7th Ave., New York City, has awarded the contract for the construction of a 200 x 600 ft. studio building on Van Alst, Ely and Moore St. and Queen's Boulevard, to the Fleischmann Construction Co., 531 7th Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $1,500,000.

N. Y., New York—The Cunard Steamship Co., 24 State St., has awarded the contract for the construction of an office building at 29 Broadway, to Hines & Todd, 101 Park Ave. A steam heating system will be installed in same. Total estimated cost, $4,000,000.

N. Y., New York—The Seaboard National Bank, 18 Broadway, has awarded the contract for the construction of a 3 story, 80 x 94 ft. bank building, on Broad and Beaver St., to the C. T. Willis Construction Co., 286 5th Ave. A steam heating system will be installed in same. Total estimated cost, $350,000.

N. Y., New York—S. Straus & Co., 127 East 26th St., has awarded the contract for the construction of a 12 story, 25 x 100 ft. office building on 30th St. and Madison Ave., to the Continental Iron & Steel Co., 2 Rector St. A steam heating system will be installed in same. Total estimated cost, $140,000.

N. Y., New York—The 22 East 70th St Corporation, 206 Broadway, has awarded the contract for the construction of a 13 story, 55 x 100 ft. hotel, at 850 Madison Ave., to Harvey, Abrams & Melius, 15 East 40th St A steam heating system will be installed in same. Total estimated cost, $500,000

N. Y., New Rochelle—The Department of Education has awarded the contract for building a 3 story school, to Emil Dieditsch, 383 Madison Ave., New York City. A steam heating system will he installed in same. Total estimated cost, $200,000.

N. Y., Syracuse—The Merrill-Soule Co. has awarded the contract for the construction of a 5 story, 61 x 90 ft. cold storage building on North Franklin and Plum St., to the Turner Construction Co., 244 Madison Ave., New York City. Total estimated cost between $80,000 and $90,000.

N. Y., Syracuse—The University Methodist Church has awarded the contract for the construction of a 1 story, 63 x 112 ft. church on East Genessee St., to E. K. Fenno, 408 South Salina St. Present heating system will be enlarged. Total estimated cost, $175,000.

N. J., Plainfield—The Board of Education has awarded the contract for the construction of a 2½ story, 55 x 150 ft. school, to the Stewart-Willey Co., 1123 Broadway, New York City. A steam heating system will be installed in same. Total estimated cost, $140,000.

N. J., Verona—Essex County (Newark) has awarded the contract for heating and piping in the proposed 3 story sanatorium, at Orange Mountains, to Gillis & Geohegan, 537 Broadway, New York City. Estimated Cost, $59,500.

Penn., Philadelphia — The Philadelphia & Reading R.R., Reading Terminal, has awarded the contract for building a power house here, to R. E. Lamb, 841 North 19th St. Philadelphia. Noted June 17.

Md., Baltimore—A. W. Wilson Memorial Methodist Episcopal Church, 3013 Guilford Ave., has awarded the contract for the construction of a 1 story, 50 x 80 ft. church, on Charles St. and University Parkway, to D. M. Andrew Co., Mount Vernon and 26th St. Steam heating and electric lighting systems will be installed in same. J. W. Smith, pastor. Total estimated cost, $200,000.

N. C., Rutherfordton—The city has awarded the contract for furnishing and installing pumps in connection with waterworks system, to Gear & Wilson, Rutherfordton.

Ohio, Cleveland—The National Malleable Castings Co., 7706 Platt Ave., has awarded the contract for the construction of a 6 story, 50 x 208 ft. office building on Quincy and Woodhill Rd., to the Crowell-Lundoff Little Co., Meriam Bldg. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ohio, Columbus—Tinker Roller Bearing Co., Dueber Ave., Canton, has awarded the contract for the construction of a 282 x 482 ft. plant, to D. W. McGrath. Plans to include a 61 x 169 ft. carbonizing house, a 61 x 66 ft. boiler house and a 36 x 62 ft. storage house, on 5th and Cleveland Ave. Estimated cost, $550,000.

Mich., Detroit—Hugh Chalmers, 275 Iroquois Ave., has awarded the contract for the construction of a 2 story, 95 x 200 ft. hall and commercial building on Woodward Ave. and Watson St., including steam heating equipment, to F. H. Goddard, 516 Franklin St. Total estimated cost, $150,000.

Mich., Detroit—The Gordon, Paged Co., 461 Chene St., has awarded the general contract for building a 2 story, 125 x 170 ft., addition to its bakery, on Hendricks and Duboise Sts., to G. D. Nutt, 632 Farwell Bldg., steel work, to The Russell Wheel & Foundry Co., Chene St. Electric power and steam heat from boilers will be installed in same.

Mich., Detroit—G. A. Lindke, Monroe and Farmer St., has awarded the contract for the construction of a 3 story, 140 x 159 ft. store and hotel, on Woodward Ave. and Peterhoro St., to the Detroit Metal & Steel Co., 1st and Congress St. A steam heating system will he installed in same. Total estimated cost, $300,000. Rogers, Bonnah & Chaffee, 526 Farwell Bldg., Arch.

Mich., Detroit—The Packard Motor Car Co East Grand Boulevard, has awarded the contract for building a 4 story, 80 x 196 and 80 x 201 ft. service station, on Woodbridge and St. Antoine St., to the Bryant & Detwiler Co., 2336 Dime Bank. A vacuum steam heating system, vacuum pump and 2 boilers will be installed in same. Noted July 29.

Ill., Bement—The Board of Education has awarded the contract for building a 3 story, 50 x 200 ft. school, to English Bros., Champaign. A steam heating system will he installed in same. Total estimated cost, $125,000.

Wis., Kiel—The Kiel Woodenware Co. has awarded the contract for furnishing and installing 2 high pressure boilers, to the Freeman Manufacturing Co., Racine. Estimated cost, $10,500. Noted July 29.

Ia., Clarinda—The city has awarded the contract for 4½ million gallon pumps, 2 low duty and 2 high duty, in connection with the proposed waterworks system, to the American Well Works, 319 Reliance Bldg., Kansas City, Mo.

Minn., Duluth—The Marshall Wells Co., Lake Ave., S., has awarded the contract for the construction of a 4 story, 115 x 250 ft. addition to warehouse, to Jacobson Bros., 410 Columbia Bldg. Steam heating and mechanical ventilating systems will be installed in same. Total estimated cost, $250,000.

Minn., St. Paul—The Northern Pacific Beneficial Association, 203 Railroad Bldg., has awarded the contract for the construction of a power house in connection with the proposed 3 story, 80 x 280 ft. hospital, on Snelling and University Ave., to J. and W. A. Elliott, 906 Lumber Exchange Bldg., Minneapolis. Total estimated cost, $500,000.

Kan., Arkansas City—A. S. Newman has awarded the contract for the construction of a 5 story, 75 x 132 ft. hotel, to the Swenson Construction Co., 11th and Oak Sts., Kansas City, Mo. A steam heating system will be installed in same. Total estimated cost, $200,000.

Kan., St. John—The city has awarded the contract for building electric light plant and stack, also equipment, to the Merkle Machinery Co., Interstate Bldg., Kansas City, Mo. Equipment includes two 80 hp. boilers and 2 generators. Total estimated cost $47,800. Noted July 29

Mo., St. Louis—The Arthur Realty Co., 6th St. and Washington Ave., has awarded the contract for the construction of an 11 story, 90 x 150 ft. store, on Washington Ave. and 6th St., to the Westlake Construction Co., 717 Locust St. A steam heating system will be installed in same. Total estimated cost, $480,000.

Col., Denver—The State Building Committee has awarded the contract for installing a steam heating system in the proposed 5 story, 112 x 114 ft. office building on the corner of Colfax Ave. and Sherman St., to McCarty & Johnson, 1418 Curtis St. Estimated cost, $13,306.

Wash., Olympia—The state has awarded the contract for installing heating system in the proposed new state buildings at Grand Mound to the Bergh-Griggs Co., Tacoma, at $11,705.

Cal., Los Banos—The Central California Creameries has awarded the contract for the construction of a 3 story, 150 x 150 ft. creamery, a 1 story power house and a 1 story warehouse, to Lange & Bergstrom, Sharon Bldg., San Francisco. Total estimated cost, $66,600.

Cal., Vallejo—Admiral Hotel Co., Inc., 808 Mechanical Institute Bldg., San Francisco, has awarded the contract for the construction of a 6 story, 80 x 130 ft. hotel here, on Virginia and Sonoma Sts., to McDonald & Kahn, Rialto Bldg., San Francisco. A steam heating system will be installed in same. Total estimated cost, $250,000.

N. B., St. John's—The Department of Public Works, Ottawa, Ont., has awarded the contract for the construction of a cofferdam, Courtenay Bay, at the entrance to dry dock, to the Bedford Construction Co., Halifax and St. John. Two 12 in. electrically driven water pumps will be installed in same.

Ont., Walkerville—The Motor Products Co., Walker Rd., has awarded the contract for the construction of a 2 story, 60 x 337 ft. factory addition, to the W. E. Wood Co., 1805 Ford Bldg., Detroit, Mich. Steam heating plant, 30" boiler, vacuum pump and receiver will be installed in same.

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POWER

Volume 50 New York, September 2, 1919 *Number* 10

To Earn More—
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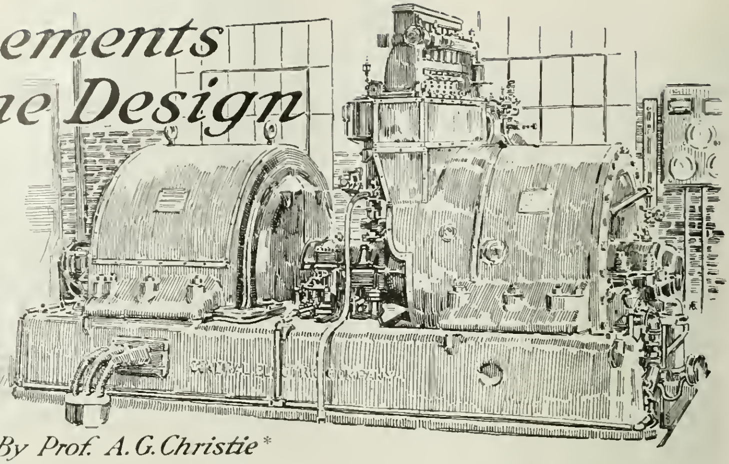
D. E. WHALEY
Power '19

His Incentive

Refinements in Turbine Design



By Prof. A. G. Christie[*]

The article deals with some of the things which are open to improvement, thus decreasing the steam consumption. Forms of throats and mouths of nozzles, polished surfaces for diaphragms and thickness of blade edges are among the things considered.

REPORTS of tests of large steam turbines that appear from time to time in the technical press show progressive advances in steam-turbine design. Steam consumption in pounds of steam per kilowatt-hour is quite low in some cases, though this is partly due to increased steam pressures and superheat and to high vacuum. The increase of the efficiency ratio referred to the Rankine Cycle has, however, been the best means of judging the improvements and refinements in design, and this ratio has increased practically since turbines were first built. The efficiency ratio on some recent turbines has reached a comparatively high value, and this leads one to consider the line of future turbine development that can still further increase this ratio.

Before entering into a discussion of the possibilities in this direction, it is well to direct attention to some factors in the relation of efficiency ratios and commercial steam-turbine design. A high efficiency ratio in a turbine indicates that its losses are reduced to a small amount through clever design of parts, through the use of small clearances and usually through the use of many stages. This means a large, expensive, carefully built machine which requires care in operation. On the other hand, its high economy makes it very desirable when its load factor and use factor are high and coal is expensive.

Such a high-grade machine is not necessary or desirable for many services, particularly when coal is cheap, load factor and use factor low, and skilled operators not available. Hence, manufacturers furnish smaller, more compact, cheaper machines for such services in which clearances are larger, reliability is increased, and the efficiency ratio is held only at a moderate figure. These machines give good service with little expert attention and serve the purpose for which they were designed.

The war has projected into the problem of steam-turbine design two new factors which are sure to have considerable influence on future machines. These are increased fuel costs and increased labor costs. Apparently, the power-plant operator can do little to decrease these costs under present conditions, so that if he is to reduce his production cost of power, he must look to a higher efficiency in main power units. In this article it is intended only indirectly to indicate the possible economies in the use of fuel through securing higher efficiency ratios in steam turbines and thereby decreasing the fuel consumption. The following paragraphs will therefore briefly suggest some further refinements in steam-turbine design that may secure the desired results.

It is hardly likely that the efficiency ratio can be greatly increased in a given turbine by a modification of any single factor in design. Improvements must be sought in refinements of the design of many of the turbine elements, a few tenths of 1 per cent. here, a few more tenths there, and still a few more tenths in several other places, which in the aggregate may result in marked improvement in the total efficiency ratio of the unit. These small amounts will be secured largely as the result of extended research, test and study of design. The expense of such development work often prevents some companies from undertaking it, but competition will force many to do much of this in the near future.

Probably more experimental work has been done on nozzles than on any other turbine part. Their efficiency is fairly high, ranging from 88 to 94 per cent. There is still an appreciable margin for improvement in this efficiency. As a nozzle alone the circular throat and mouth give the most efficient form. When the delivery of the jet onto turbine blades is considered, the two ends of the jet from an eliptical nozzle mouth do not completely fill the blades they enter and eddies are set up. This is overcome with a rectangular mouth.

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[*] Department of Mechanical Engineering, Johns Hopkins University, Baltimore, Md.

Should the nozzle, therefore, have a square throat and rectangular mouth or a round throat and rectangular mouth, and what should be the relative length, flare of sides and size of mouth for various diameters of throat and ranges of expansion? Further experimental work on nozzles in the light of Martin's recently published theory offers some possibilities for the improvement of nozzle efficiency.

In multiple-stage impulse turbines the orifices in the diaphragms usually consist of sheet-steel partitions bent to form and cast in place. These seldom have a high polish and in any case corrode more or less in service. Friction losses would be decreased were these made of a brass or bronze that could be highly polished and would retain the polish. Furthermore, there is reason to believe that a certain amount of eddying takes place in these orifices which might be prevented if the rear of the orifice were flattened out to conform to stream lines in the same manner that blades are thickened at the center. Such built-up orifices have been used by one manufacturer, and improved results are reported.

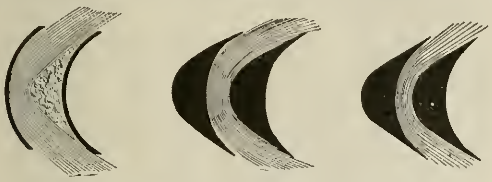

FIG. 1. BEHAVIOR OF JETS IN BLADES†

Friction losses in steam jets crossing blades are very difficult to determine accurately. The condition of the blade surface, whether rough or smooth, is an important factor. The correct width of blade is another factor. A wide blade would appear to reverse a jet with least shock, but the added length of wall increases the surface friction. A narrow blade may cause shock and eddies by too sudden reversal. The blade must be wide enough and thick enough at the center to withstand shock and keep vibration to a minimum. The thickness of the blade at the center and the stream-line effect of the flowing jet are factors deserving much attention. Apparently, much study can still be devoted to blading material and blade shapes.

Several companies building impulse turbines have adopted the practice of increasing the inlet angle of the blades beyond that required by the velocity diagram. In England this is said to have practically no effect on economy at full load and seems to improve performance with low steam pressure or at light loads. A study of the effect of shock on moving blades will indicate how far this inlet angle may be increased to advantage.

The thickness of the inlet and outlet edges of the blades has been varied over wide ranges. Usually, this thickness has been governed by manufacturing and mechanical requirements rather than by a consideration of the effect of shock on the steam jet. The edges must be thick enough not to wear away rapidly from erosion or corrosion. Too thin edges do not make strong blades. Most impulse blades now have a distinct thickness on the inlet side. Here, again, a study of shock on blades might indicate a form of blade edge that would conform more to divide stream lines of the flowing jet and thus lessen shock at this point.

Several turbine builders, both in this country and in Europe, have made it a practice to give a high polish at all interior portions of their turbines that are exposed to moving steam. This is an excellent plan and could be adopted by all builders.

In impulse turbines the friction losses of the disks are of considerable magnitude, particularly in the high-pressure stages. The whirling losses due to churning in the blades which are not filled with a stream jet are also relatively large in the high-pressure sections of the turbine. European designers are said to be building their diaphragms so as to inclose the disks and blades more tightly than heretofore. One American builder has inclosed the rotating blades that are not opposite nozzles by a U-shaped cover to decrease this whirling loss. Another manufacturer uses a small-diameter disk on the first stage and allows the disk diameter to increase progressively to the last stage. This lessens the disk friction in the early stages when the steam is more dense and also decreases the ratio of empty to steam-filled blades on the disk. There are, therefore, some refinements possible in disk and diaphragm design that may appreciably decrease the whirling losses.

Cast iron is subject to growth when continuously exposed to high temperatures. Hence, the high-pressure cylinder section and diaphragms of turbines using high pressure and superheat must be made of cast steel thoroughly annealed. This is expensive construction, but must be used to avoid accidents resulting from distortion due to the growth of the cast iron.

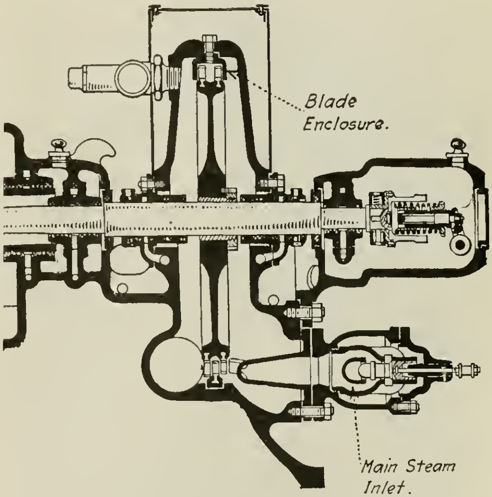

FIG. 2. SHOWING ENCLOSURE FOR BLADES

A water gland consists of a small centrifugal pump impeller fixed firmly on the turbine shaft and designed to maintain a solid band of water under a pressure of 10 or 15 lb. around the periphery of the impeller. This band of water prevents air leaking into the exhaust ends of the cylinder casing. As a centrifugal pump its efficiency is low, and generally little attention is given to the design of the impellers to get improved efficiency. The power required to drive this pump may be materially reduced by giving it the careful attention that a high-grade centrifugal-pump design involves.

Labyrinth packings are used extensively for casing glands and diaphragms. Some experimental work abroad showed that there was a great difference in the steam leakage past various forms of labyrinth glands. These forms of glands have only recently received much attention in this country. Improved designs should decrease gland leakage materially.

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†Illustrations from among those that will appear in Marine Engineers' Handbook.

All the earlier labyrinth glands had the labyrinth teeth cut on the stationary element. If a serious rub occurred it was on a portion of the rotating shaft where quite excessive heating often developed which frequently resulted in a sprung shaft. This design is wrong. A much better plan now being adopted by an American manufacturer is to cut deep, thin labyrinth teeth on the rotating shaft, leaving the diaphragm comparatively smooth. If a rub now occurs, the fine teeth dissipate the heat before it reaches the shaft proper. There is less chance for local overheating to spring the shaft, and there is also more opportunity to introduce improved gland constructions.

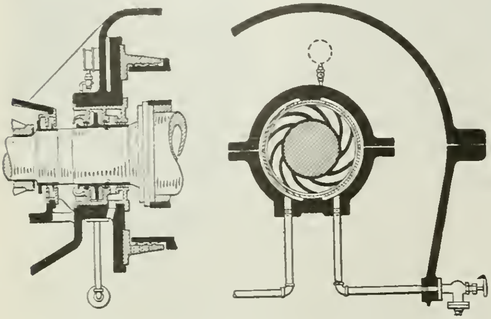


FIG. 3. SECTION SHOWING WATER SEAL

The efficiency of the Parsons turbine could be considerably increased if leakage losses over the ends of the blades could be diminished. The clearances over the ends of these blades are fixed by mechanical considerations and probably will not be decreased beyond present practice. It is questionable whether any shroud device with labyrinth packing over the blade tips would decrease leakage sufficiently to offset the increased whirling losses. However, the labyrinth packings on the sides of blades in the Ljungstrom turbines suggest some similar construction for Parsons units which may eventually be worked out to decrease leakage losses.

For highest economy the blade speed in impulse turbines should be about 45 per cent. of the steam speed and in Parsons turbines about 90 per cent. These values are not realized in practice, for to do so either the steam speed must be low and the number of stages large or if the number of stages is to be few the wheel speeds become too high. Many stages mean large expensive turbines, hence designers have aimed toward higher wheel speeds. Large turbines with blade speeds of 860 ft. per sec. are operating. If this figure is to be exceeded, some form of alloy steel must be employed for disks and blades which will safely withstand these heavy strains. Some designers prefer quite moderate speeds, sacrificing economy to safety. There is every probability, however, that blade speeds will be increased as experience in steam-turbine materials accumulates.

Vibration in turbine blading is still one of the engineer's most difficult problems. Little is known of the theoretical nature of this vibration, though it is generally assumed to be of the nature of a harmonic. Does the blade act like a beam held at one end and uniformly loaded? If so, what is the effect of the shroud and of intermediate lacing? Finally, does it have a period of vibration due to the steam velocity? If the theoretical analyses were fully developed, engineers would be able readily to devise means for overcoming vibration.

Parsons-turbine design presents quite another set of problems to that of impulse turbines. Reference has already been made to water glands and to leakage over blade tips. Leakage past the balance piston is a source of loss that may be reduced. The form of dummies in such pistons may be subject to modification so that this loss can be considerably diminished. One form proposed carries several faces on each dummy which cause repeated throttlings as the steam seeks to leak inward over the dummy.

Parsons blade forms are largely the result of cut-and-try methods. The front and rear curves of the blades, the effect of thickness at the entering and leaving edges and the reinforcing of these blades against vibration are matters demanding further study by the engineer. In reference to the effect of thickness on the outlet side, British engineers are inclined to believe that this has no effect on stream flow. American designers believe that it has some effect and generally make allowance for this thickness.

Another theoretical consideration in Parsons' design is the effect of the carry-over velocity from one row on the succeeding row. Does the jet continue into the next row at the absolute leaving velocity of the preceding row, or is this velocity reconverted into heat and thus partly lost as reheat? Apparently, part of both these effects takes place, though to what extent is not definitely established. If the jet can be continued without reheating effect, a possible gain might result.

The wear of blading materials is an important consideration. Many troubles with blade failures have led to an intensive study of blade materials. The first and last blades usually are subject to the most extreme conditions. The first have to withstand high temperature; the last are subject to wet steam and at the same time to high centrifugal forces and sometimes to severe vibrations. Much remains to be done to develop the best material for these two extreme conditions. At present no material seems available to fulfill all the desirable requirements of either.

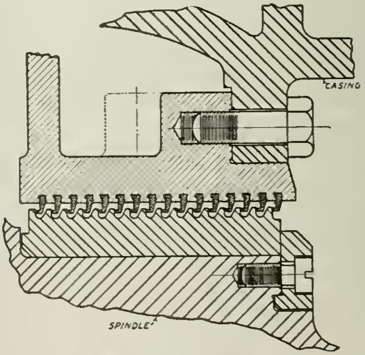
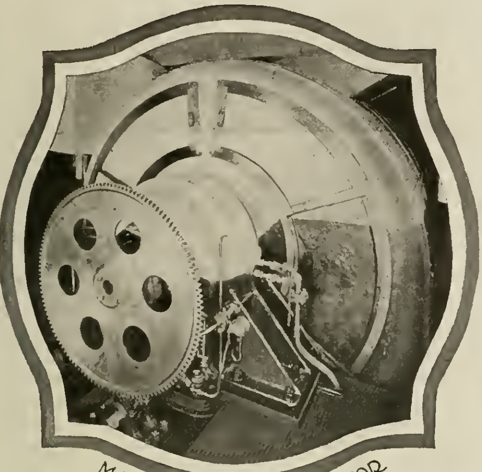


FIG. 4. LABYRINTH PACKING IN SECTION

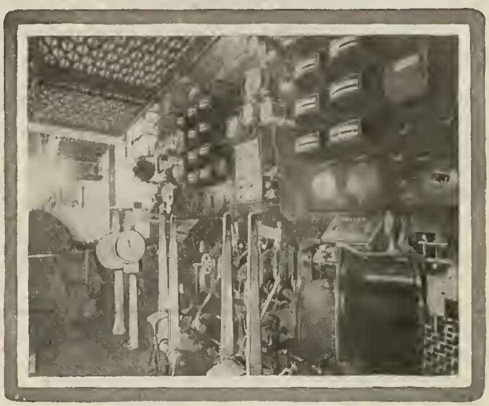
The preceding paragraphs outline briefly some of the problems of steam-turbine design that are occupying the attention of engineers. Owners and operators of turbines are interested in their further development.

ELECTRIC DRIVE OF U.S.S. NEW MEXICO

Glimpses Below Decks

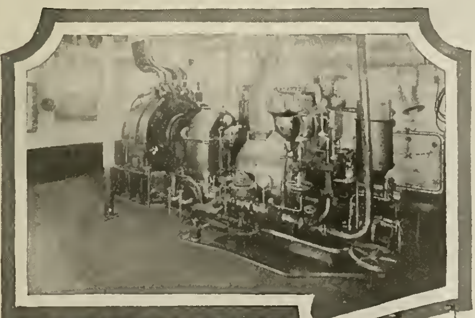


MAIN STARBOARD GENERATOR

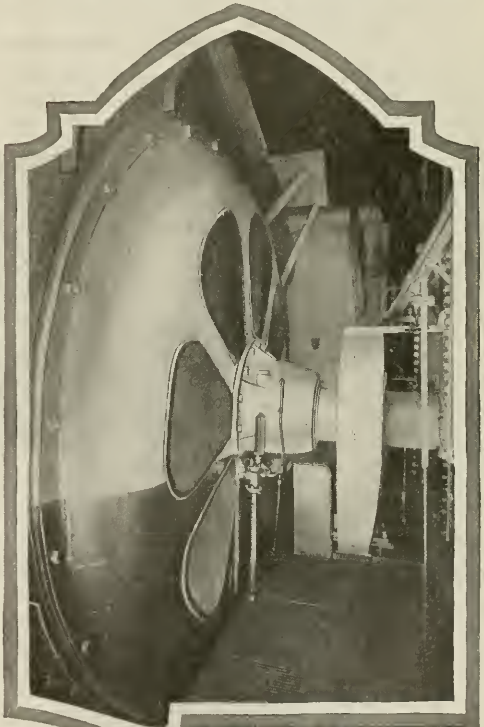


CENTRAL CONTROL BOARD

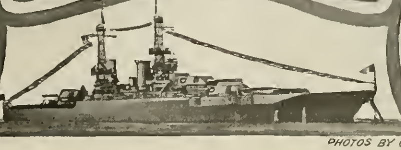
ONE OF THE MAIN BOILER ROOMS
SHOWING OIL-FIRED BOILERS



ONE OF SIX TURBO-GENERATOR SETS SUPPLYING AUXILIARY SERVICE



7000-HP. MOTOR DRIVING STARBOARD PROPELLER



PHOTOS BY COURTESY OF GENERAL ELECTRIC CO.

What is the Synchronous Motor?

By Will Brown*

By comparison with an engine-driven alternator and line sketches showing the relative positions of opposing poles on the rotor and the stator, the author explains simply the actions of the synchronous motor, telling how it is started, how pulled into step, or it falls out of synchronism.

IT IS useless to try to describe a synchronous motor unless the reader thoroughly grasps a few fundamental principles upon which this type of motor operates. If one gets the proper picture of what takes place when a synchronous motor starts and runs, one can understand the real difference between this type of motor and the better-known induction motor. Such questions as flywheel effect, starting current, power factor and overload capacity can be discussed only in the light of this knowledge.

As far as appearances go, a synchronous motor and an alternator are alike. A 400-hp. 200-r.p.m. engine-type synchronous motor looks like a 300 kv.-a 200 r.p.m. engine-type alternator. The only difference that will be noticed is the short-circuited squirrel-cage winding on the rotor of the synchronous motor. There are a few other changes in design sometimes found, which will be described later.

WILL BROWN

Synchronous motors and alternators are made in the same types—direct-coupled, belted, engine-type and vertical. Any turbo-alternator can be operated as a synchronous motor supplying reactive kilovolt-amperes only, or delivering just enough mechanical power to overcome the losses in the machine. Rotor and stator, slip rings, exciter and all other details are practically identical in alternators and synchronous motors. It is assumed that the reader is familiar enough with alternators of various types to render further description unnecessary. Let us consider just what a synchronous motor is doing under various conditions of line voltage and load.

Suppose you are starting up an engine-driven alternator to run in parallel with other alternators on a 60-cycle system. If the paralleling switch should be prematurely closed as the alternator approaches 60-cycle frequency (near full speed), there would be a noticeable tendency to race ahead and pull the engine with it. This corresponds to the pull-in of a synchronous motor. When the alternator is synchronized, it is a well-known fact that raising the field excitation will not cause it to take a load. The ammeter shows a current proportional to the increase in excitation, but the wattmeter indicates no load. The alternator is simply delivering wattless current. Now, if the operator increases the steam supply to the engine, there will be a tendency for the engine to speed up; but this can take place only for a small space of time—a fraction of a second. The frequency of the circuit limits the speed of the alternator. During this infinitesimal period of time the phase of the alternator has been slightly advanced as compared to the phase of the line—and now the alternator is picking up its load.

What has happened is really this: When the alternator is brought to synchronous speed with the line, every magnetic pole on the revolving rotor is exactly opposite a revolving magnetic pole on the stator. A north pole of the rotor and a south pole of the stator are locked together, as in Fig. 2. When the engine is speeded up, the rotor poles move forward as in Fig. 3, and then continue revolving at constant speed with the stator field.

The distance from *A* to *B*, measured in electrical degrees, represents the phase

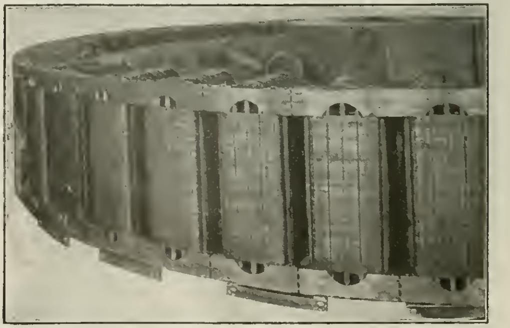


FIG. 1. SQUIRREL-CAGE WINDING ON ROTOR USED FOR STARTING

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*Service sales manager, Electric Machinery Co., Minneapolis, Minn.

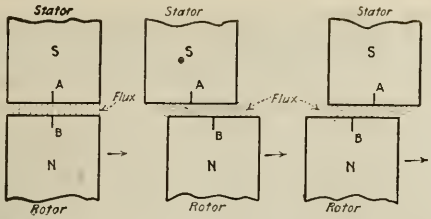


Fig. - Fig. 3 Fig. 4

FIGS. 2 TO 4. RELATION BETWEEN ROTOR AND STATOR POLES

displacement. If this distance is increased, the load on the alternator rises; if decreased, the load falls.

Now, suppose the steam is shut off from the driving engine. The alternator will still continue to run and drive the dead engine. It has now become a synchronous motor. Here is what happens: The poles of the rotor drop back from the leading position shown in Fig. 3 because there is no prime mover to push them forward. Almost instantly they are back at the position shown by Fig. 2. But since there is a considerable load now dragging the rotor back (the dead engine), the rotor poles continue falling back to the position shown in Fig. 4.

If the load on the rotor is increased still further, the distance *AB* will increase. It is understood that the excitation has remained constant. This is the condition on a load-driving synchronous motor. The distance *AB* is referred to as angular displacement and can never exceed one-half of a pole pitch, or 90 electrical degrees. The amount of load that the motor can carry at any specified field strength (excitation) is limited. When the rotor poles fall back half a pole pitch behind the stator poles, the rotor falls out of step. The force holding together the poles of the stator and the poles of the rotor suddenly snaps like a breaking rubber band, and the rotor stops, while the magnetic poles of the stator continue on at constant speed. This is what happens when a synchronous motor is overloaded and pulls out of step, and is called the motor's pull-out point. Of course, in actual practice the circuit-breakers will generally disconnect the line from the motor before it reaches this point, because of the enormous current that the motor would be pulling from the line. It is possible, then, to draw the following conclusions:

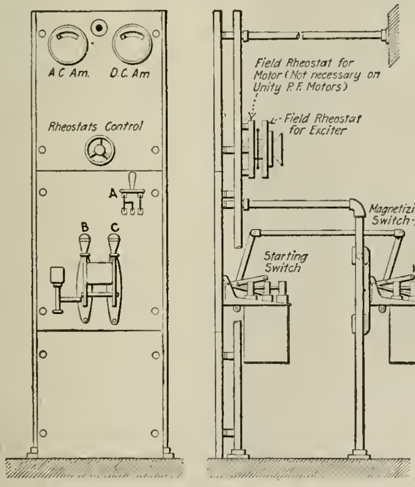

A C Am.
D.C. Am
Rheostats Control
A
B
C
Field Rheostat for Motor (Not necessary on Unity P.F. Motors)
Field Rheostat for Exciter
Magnetizing Switch
Starting Switch

FIG. 5. SYNCHRONOUS-MOTOR STARTING PANEL

First: The rotor poles of an alternator are being pushed by the prime mover at a certain angular displacement ahead of the stator poles, while the rotor poles of a synchronous motor are being pulled around at a certain angular displacement behind the stator poles. If that simple fact is kept in mind, it will help greatly in understanding synchronous-motor characteristics.

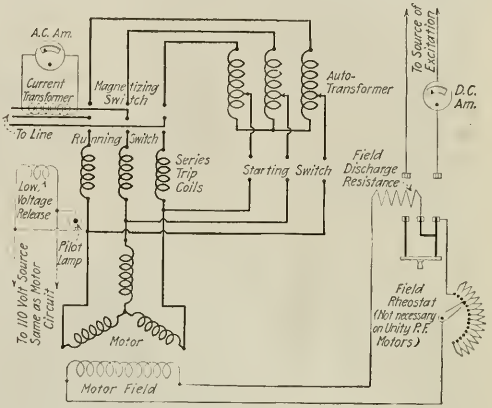


FIG. 6. WIRING DIAGRAM FOR PANEL FIG. 5

Second: There is a variation of angular displacement with every variation of load, but there is a limit to the load that a synchronous motor can carry under specified excitation and the angular displacement can never exceed 90 electrical degrees, or one-half a pole pitch.

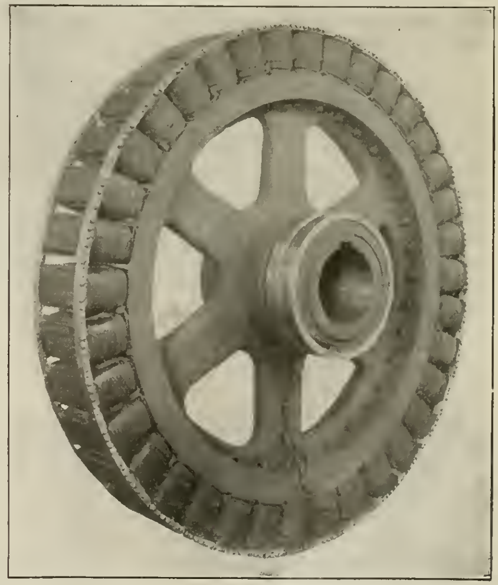


FIG. 7. ROTOR 60-CYCLE SYNCHRONOUS MOTOR

Third: Both the alternator and the synchronous motor can be operated at full field strength without delivering any power except losses in the machine itself. In both cases the current will be reactive or wattless current. This is called running as a condenser.

Fourth: Both the alternator and the synchronous motor can operate only at line frequency, so there is no possibility of variable speed in either case.

Fifth: As in the case of an alternator the synchronizing power increases as the frequency of the alternator approaches the frequency of the line. So it is with a synchronous motor. It is necessary that some prime mover bring the speed of the alternator nearly to syncronous speed before this power is noticeable. Also with the synchronous motor it is necessary that some starting power be used to bring the motor up to a speed approaching synchronism before the pull-in power of the line can be exerted.

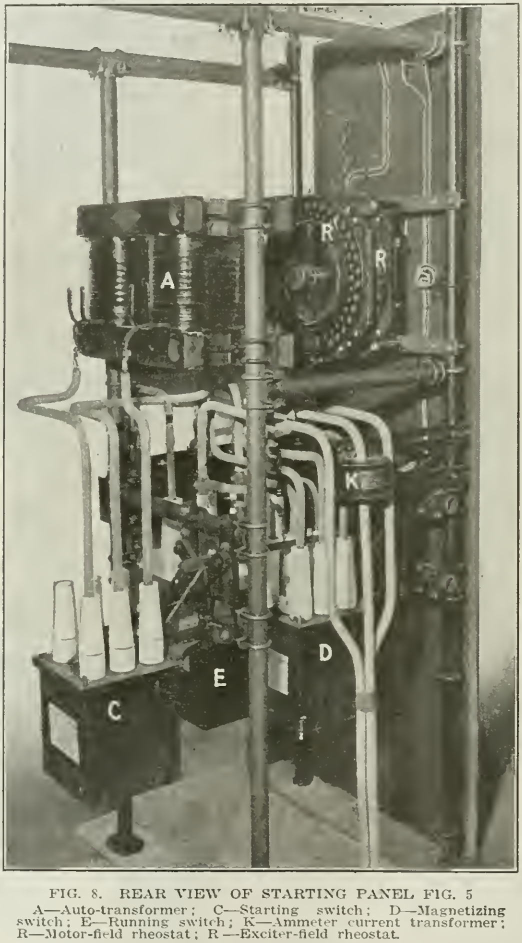


FIG. 8. REAR VIEW OF STARTING PANEL FIG. 5
A—Auto-transformer; C—Starting switch; D—Magnetizing switch; E—Running switch; K—Ammeter current transformer; R—Motor-field rheostat; R —Exciter-field rheostat.

Let us see just what happens when a synchronous motor is started. It is necessary that field switch *A*, Fig. 5, be open and in contact with the field discharge clip so that the field is closed through the field-discharge resistance in series. The motor should always be started with the field circuit closed through resistance; if open-circuited, there would be a dangerously high induced voltage at the field terminals and field switch. The exciter rheostat is set about halfway around at starting. When the starting switch and the magnetizing switch are operated in tandem, as in Fig. 5, the operator throws in switch lever *B*. This closes both the magnetizing and starting switches and immediately starts the motor on part voltage and brings it rapidly up to maximum speed.

The time required for this varies with different cases according to motor design and kind of load. It is possible for a large motor to come up to speed in eight seconds; in some cases it may require half a minute or more. By watching the ammeter, the operator can judge best when to throw on full voltage—the amperes gradually lower. When the ammeter's pointer becomes stationary or practically so, the operator opens switch *B* and closes the line switch *C*, which throws full voltage on the motor. This should bring the motor almost immediately to full speed in step with the line. Just before synchronizing, the ammeter pointer will fluctuate violently and then come to rest as soon as the motor has pulled in. Then the field switch is closed. As a matter of fact, the field switch could be closed before the motor has pulled into step, but the operator must be careful. The motor should generally reach 95 per cent. of full speed before the field switch is closed. If properly done, this will help considerably in pulling in, as it increases the synchronizing power. Most operators, however, prefer not to close the field switch until the motor is at full speed. The motor pulls into step with a fairly heavy rush of current, which falls almost instantly and the motor settles down to steady running. The whole operation should rarely exceed half a minute.

By regulating the exciting current, the operator can bring the motor to unity power factor, or leading if desirable. It is always possible to tell when unity power factor is reached; the line amperes are at a minimum. Any higher resistance or lower resistance in the field circuit causes the line amperes to rise, provided the load remains the same. With a given rheostat setting, in the field circuit, the power factor of a synchronous motor decreases as the load increases, and increases as the load decreases. However this is not a disadvantage as might at first thought be the conclusion, but an advantage, since the excitation may be adjusted to give unity power factor at the maximum load the motor will be required to drive. At loads below this the motor will supply a leading current to the line which will help to compensate for the lagging power factor of the system. In the next article attention will be given to the motor under load.

It is stated that the total mileage under electric operation in the United States is 265,218, against 713,120 for the rest of the world. The former represented 400,000 miles of single-track and there were, in addition, 50,000 miles of street and urban electric railways. There are 675 electric locomotives, as compared with 450 for the rest of the world.

ENERGY STORED *in a* STEAM BOILER

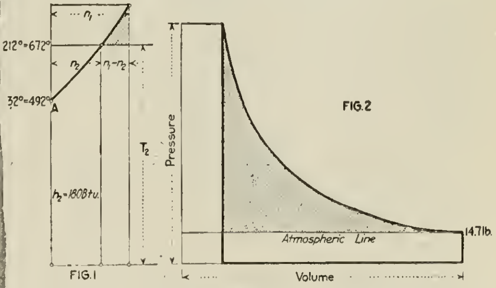
By Fred R. Low

In presenting to legislative committees, industrial commissions, etc., arguments for the governmental supervision of boilers, it is desirable to show how much energy is stored in these receptacles, which lurk under sidewalks, in cellars beneath stores, hotels and other buildings where the public gathers, or in factories where hundreds of human beings toil.

The accompanying table has been computed for this purpose.

Pressure Abs., Lb. per Sq. In.	Energy Stored in Water				Energy Stored in Steam			
	Per Pound		Per Cubic Foot		Per Pound		Per Cubic Foot	
	B.t.u.	Ft.-Lb	B.t.u.	Ft.-Lb.	B.t.u.	Ft.-Lb.	B.t.u.	Ft.-Lb
20	0.18	141.4	10.79	8,392	2.65	2,059	0.13	103
25	0.59	461.7	35.10	27,291	7.97	6,120	0.48	376
30	1.05	819.1	61.98	48,189	13.42	10,436	0.98	760
35	1.56	1,211.0	91.00	70,905	20.65	16,058	1.74	1,350
40	2.23	1,737.2	136.44	106.091	23.85	18,544	2.27	1,767
45	2.75	2,138.7	159.84	124,280	29.14	22,659	3.10	2,413
50	3.27	2,543.7	189.62	147,434	33.88	26,343	3.98	3,095
55	3.90	3,030.0	224.66	174,679	38.32	29,793	4.92	3,828
60	4.59	3,570.8	262.27	203,927	42.84	33,311	5.97	4,643
65	5.16	4,009.4	295.63	229,862	46.81	36,400	7.04	5,471
70	5.76	4,476.0	331.58	257,817	50.69	39,417	8.17	6,354
75	6.33	4,918.2	360.54	280,336	54.25	42,178	9.34	7,259
80	6.83	5,309.2	387.85	301,567	57.79	44,933	10.57	8,218
85	7.43	5,780.5	421.52	327,752	61.05	47,472	11.83	9,282
90	8.01	6,226.1	453.70	352,769	64.20	49,921	13.12	10,204
95	8.65	6,725.1	488.68	379,492	67.21	52,256	14.46	11,240
100	9.16	7,121.6	515.69	400,970	70.06	54,474	15.82	12,300
105	9.77	7,595.6	548.51	426,490	72.90	56,684	17.24	13,406
110	10.25	7,966.9	573.79	446,147	75.56	58,751	18.68	14,523
115	10.86	8,442.7	605.89	471,102	78.06	60,694	20.12	15,641
120	11.34	8,815.2	634.21	493,123	81.58	63,433	21.89	17,019
125	11.85	9,214.5	661.27	514,167	83.02	64,551	23.17	18,016
130	12.32	9,580.4	686.30	533,627	85.32	66,338	24.72	19,218
135	12.95	10,066.2	719.43	559,382	86.50	67,255	25.97	20,190
140	13.35	10,381.1	740.99	576,151	89.70	69,746	27.87	21,670
145	13.81	10,738.2	765.10	594,897	91.70	71,301	29.46	22,909
150	14.26	11,087.6	787.14	612,034	93.64	72,811	31.09	24,173
155	14.74	11,463.5	812.36	631,639	95.78	74,472	32.80	25,507
160	15.23	11,839.5	837.48	651,174	97.62	75,903	34.45	26,786
165	15.74	12,242.3	869.40	672,102	99.41	77,294	36.11	28,081
170	16.23	12,619.4	889.07	691,291	101.27	78,740	37.86	29,433
175	16.72	12,996.6	914.86	711,341	102.92	80,026	39.55	30,754
180	17.17	13,348.2	938.70	729,879	104.75	81,445	41.35	32,154
185	17.69	13,752.1	963.93	749,490	108.52	84,376	43.97	34,189
190	18.21	14,156.0	990.41	770,085	109.11	84,840	45.36	35,075
195	18.76	14,586.5	1,019.78	792,922	109.74	85,329	46.77	36,861
200	19.15	14,887.0	1,039.64	808,365	111.23	86,489	48.61	37,796
205	19.90	15,473.1	1,080.58	840,191	112.73	87,654	50.39	39,181
210	20.02	15,567.1	1,085.14	843,738	114.72	89,203	52.43	40,766
215	20.54	15,972.9	1,113.43	865,733	115.61	89,891	54.11	42,069
220	20.86	16,221.7	1,125.34	874,996	117.06	91,020	55.96	43,507
225	21.35	16,601.2	1,148.68	893,143	118.44	92,095	57.92	45,035
230	21.74	16,902.9	1,167.38	907,684	119.66	93,042	59.71	46,428
235	22.03	17,126.9	1,178.44	916,288	121.00	94,086	61.59	47,868
240	22.48	17,481.1	1,202.82	935,240	122.31	95,100	62.92	49,452
245	22.90	17,809.3	1,223.11	951,018	123.58	96,087	65.50	50,926
250	23.40	18,190.7	1,249.30	971,384	124.82	97,055	67.53	52,507
260	24.21	18,821.2	1,290.19	1,003,171	127.41	99,067	71.48	55,576
270	25.04	19,471.5	1,332.26	1,035,882	129.53	100,713	75.39	58,615
280	25.87	20,111.7	1,373.47	1,067,931	131.72	102,414	79.42	61,756
290	26.58	20,666.5	1,403.39	1,091,190	133.91	104,122	83.56	64,972
300	27.33	21,247.9	1,440.14	1,119,765	135.99	105,736	87.71	68,200
310	28.04	21,803.8	1,475.01	1,146,879	137.29	106,748	91.43	71,094
320	28.82	22,411.9	1,510.38	1,174,383	139.99	108,847	96.17	74,778
330	29.57	22,994.4	1,546.68	1,202,608	141.95	110,371	100.50	78,143
340	30.39	23,629.3	1,586.35	1,233,449	143.82	111,826	104.84	81,521
350	31.07	24,160.8	1,618.92	1,258,778	146.04	113,552	109.53	85,164
360	31.92	24,822.3	1,660.05	1,290,758	147.38	114,590	113.48	88,234
370	32.64	25,380.5	1,694.12	1,317,246	149.13	115,954	117.96	91,719
380	33.36	25,938.7	1,724.71	1,341,029	150.75	117,214	122.41	95,178
390	33.98	26,419.2	1,753.26	1,363,229	152.31	118,425	126.87	98,648
400	34.33	26,691.9	1,767.92	1,374,631	154.51	120,134	132.87	103,315
410	35.31	27,457.8	1,811.59	1,408,586	155.77	121,119	137.08	106,585
420	35.80	27,835.0	1,832.90	1,425,151	157.04	122,106	141.34	109,896
430	36.62	28,473.2	1,871.26	1,454,981	158.31	123,096	145.65	113,248
440	37.94	29,500.3	1,938.76	1,507,467	159.59	124,089	150.02	116,643
450	38.43	29,877.4	1,959.71	1,523,749	161.87	125,861	155.40	120,827
460	39.25	30,515.7	1,993.72	1,550,199	163.15	126,857	161.52	125,589
470	40.07	30,154.0	2,031.42	1,579,508	164.44	127,857	166.08	129,135
480	40.72	31,661.7	2,060.46	1,602,084	165.06	128,341	170.01	132,192
490	41.71	32,430.6	2,106.31	1,637,744	167.34	130,116	175.71	136,622
500	42.53	33,068.9	2,139.26	1,663,363	167.96	130,598	181.40	141,046

It gives, not the entire energy stored in the contents of the boiler, but such portion of that energy as would be available to do damage or create disturbance in case the boiler exploded. This is represented by the shaded area in the pressure-volume diagram, Fig. 2, in the case of steam, and in the temperature-entropy diagram, Fig. 1, in the case of water.



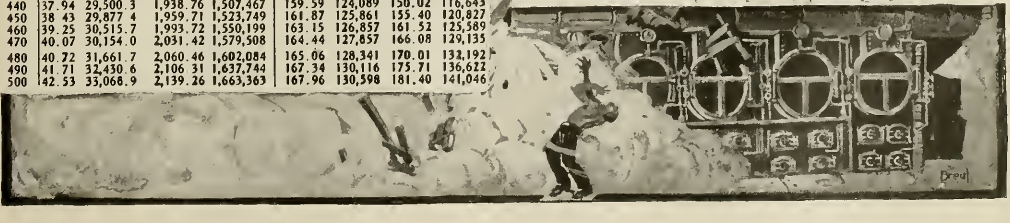
FIGS. 1 AND 2. SHADED AREAS INDICATE HEAT AND ENERGY CONSIDERED AVAILABLE

The formulas by which the table was computed are, for the steam,

$$U = E_1 - h_2 - (N_1 - n_2)\,T_2$$

and for the water

$$U = h_1 - h_2 - (n_1 - n_2)\,T_2$$



where

U = The heat converted into external energy per pound;

E_1 = The internal energy of the steam in the initial condition;

h_1 = The heat of the liquid in the initial condition;

h_2 = The heat of the liquid at 212 deg.;

N_1 = The entropy of the steam in the initial condition:

n_1 = The entropy of the liquid in the initial condition;

n_2 = The entropy of the liquid at 212 deg.

T_2 = The absolute temperature at 212 deg. F.

The table is divided into two portions, one dealing with the water and the other with the steam, and gives the energy that would be released and available to produce disturbance, in addition to the displacement of the atmosphere, for each pound and each cubic foot of contents, and gives these energies both in foot-pounds and B.t.u. The pressures given in the first column are absolute, and the values of the table are the energies developed by a drop from the pressure at the ends of the line to atmospheric pressure, 14.7 lb. abs. or 212 deg.

For example: A horizontal tubular boiler contains 284 cu.ft. of water and 102 cu.ft. of steam. How many foot-pounds of energy would be available to produce destruction if the boiler exploded under 165-lb. pressure absolute:

In the last column of that portion of the table dealing with the water it is shown that when the pressure is reduced from 165 lb. to that of the atmosphere, each cubic foot of the water will release 672,102 ft.-lb. The 284 cu.ft. of water would therefore release

$$284 \times 672{,}102 = 190{,}876{,}968 \textit{ ft.-lb.}$$

In the last column of that portion of the table dealing with the steam, it is shown that expanding from 165 lb. to the pressure of the atmosphere each cubic foot of steam will release 28,081 ft.-lb. of energy available to produce trouble, and the 102 cu.ft. would release

$$28{,}081 \times 102 = 2{,}864{,}262 \textit{ ft.-lb.}$$

The total energy released and available for destruction would be

By the water	190,876,968	
By the steam	2,864,262	
Total	193,741,230	ft.-lb.

The values used in making the table were taken from the steam tables of Marks and Davis, and in converting B.t.u. to foot-pounds the equivalent 777.54 used in those tables has been employed.

Large Motor-Driven Turbo-Blower

The Tennessee Copper Co. a few months ago, placed in operation at its Copperhill, Tenn., plant, a synchronous motor-driven turbo-blower. The unit consists of four double-inlet wheels contained in two separate casings, each wheel having a separate discharge volute, as shown in Fig. 1. The blower is driven by a three-phase 60-cycle 2300-volt 1700-hp. self-starting synchonous motor, operating at 3600 r.p.m. The extreme compactness of the unit is shown by the dimensions: Length, 32 ft. 9 in.; width, 8 ft. 7 in.; height, 5 ft. 11 in.

The volume of air delivered by this machine is probably the largest ever delivered by a single unit. The blower discharges the air into the main air line, which directs the blast into several copper smelters. When working normally, the machine delivers 125,000 cu.ft. of air per minute at a pressure of 50 ounces.

The Copperhill plant of the Tennessee Copper Co., where this unit is installed, has already in operation several turbo-blowers, also manufactured by the Rateau Battu Smoot Co., New York City. These include a steam-turbine driven unit that has a capacity of 60,000 cu.ft. of air per min. at a pressure of 50 oz. and a motor-driven turbo-blower having a capacity of 12,500 cu.ft. of air per minute at a pressure of 16 lb.

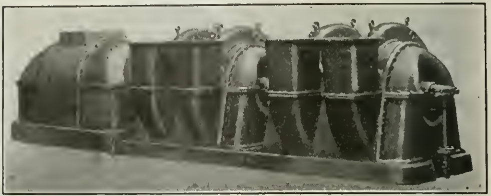


FIG. 1. TURBO-BLOWER AND MOTOR COMPLETE

Fig. 2 shows the curves of efficiencies at varying volumes and pressures for the 125,000 cu.ft. per min. motor-driven turbo-blower to which reference is made in the foregoing.

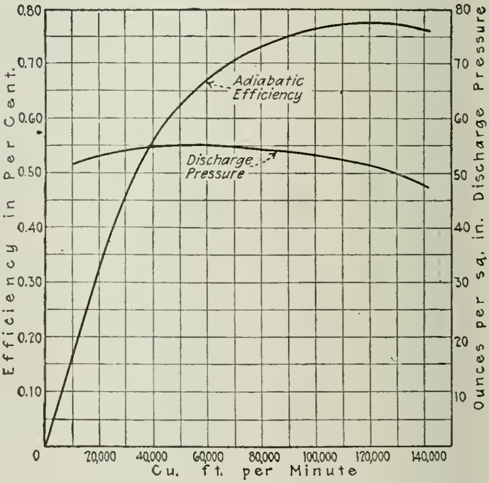
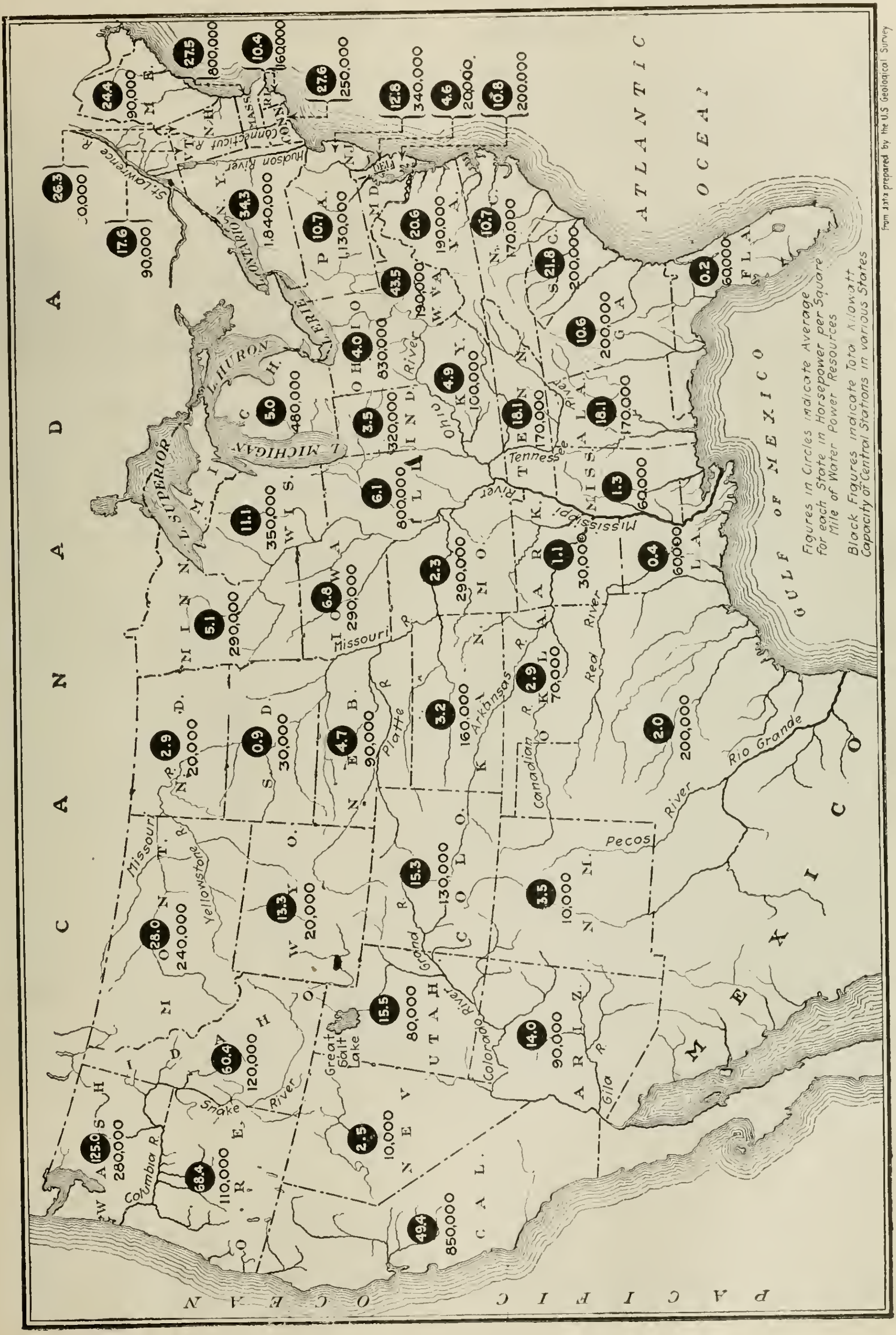


FIG. 2. EFFICIENCY AND DISCHARGE-PRESSURE CURVE

The steam turbine-driven blower was installed about eight years ago, has been operating continuously for 98 per cent. of the time, and the cost of repairs has been practically nil.

Experiments have demonstrated that concrete is impermeable to oils of low gravity under heads up to 24-ft. Concrete tanks for fuel oil storage have been constructed without any special treatment beyond a rich coating of cement mortar applied immediately after the forms were removed, worked into the surface and then lightly trowelled. In some instances a solution of sodium silicate or water glass has been applied.



Figures in Circles indicate Average for each State in Horsepower per Square Mile of Water Power Resources

Black Figures indicate Total Kilowatt Capacity of Central Stations in various States

From data prepared by the U.S. Geological Survey

DISTRIBUTION OF WATER POWER AND CENTRAL STATION POWER IN THE UNITED STATES

Flywheel Bursts at Racine, Wis.

At 4 p. m. on the afternoon of Aug. 15 a 14-ft., 16-ton flywheel exploded at the Racine Industrial Plant, which supplies power and light to sixteen different tenants. There was one fatality and four men were injured, two seriously and the other two badly bruised. The property damage is estimated at $15,000.

The damaged unit consisted of a simple Corliss engine, 20x42-in., making 90 r.p.m. and operating under a steam pressure at the engine of 135 lb. The speed was controlled by the usual flyball governor belted to the main shaft. The flywheel was of the split type, cast in halves and bolted together at the hub and rim, the rim joints being midway between the spokes. The hub was secured by four 2½-in. bolts and each rim joint had four 2-in. bolts. The rim section was 27 in. wide and about 2½ in. thick with a flange at each edge and reinforcement at the center.

Serving as a pulley the flywheel was used to drive two generators by means of a double belt, the longer belt with 39-ft. centers running over the shorter belt with 29-ft. centers. Both belts were two-ply leather, 24 in. wide and weighing 32 oz. to the square foot. The inner belt drove a 150-kw., a.c. generator through an iron-core paper-rim pulley overhanging from the bearing at the side of the generator. A 200 kw., d.c. machine was driven by the longer belt. This unit was provided with an outboard bearing to carry the driven pulley which was 44 in. diameter and was made up of a wooden rim supported by two sets of iron spokes attached to a single hub.

Both generators delivered 220-volt current. They were never fully loaded, as their combined capacity exceeded that of the engine. At the time of the accident the load on both machines totaled about 125 kilowatts. The engine and flywheel had been in service 14 years.

THROTTLE VALVE HARD TO REACH

The engine was located in a corner of the engine room with the flywheel and belts on the inside as shown in Fig. 1, the throttle projecting from the steam pipe toward the plane of the wheel. From the interior of the engine room the throttle could be reached only by passing around the generators or around the flywheel and engine to the cylinder head. It was an awkward place to reach so that upon the first indication of trouble the assistant engineer rushed for the boiler room to shut off the steam. In doing so he had to pass out a side door and step in line with the flywheel. At that instant the wheel let go, hurling pieces of the rim through the wall and killing him. These pieces are shown in Fig. 3.

In sections varying from 1 to 3 ft. long the rim broke away from the spokes at the points of their smallest cross-sections, leaving the spokes attached to the hub as shown in Fig. 2. Several other pieces coming through the end wall continued their flight through an open space between two buildings housing the Wallace Tractor Co. It was here that the four men were injured. They were working on tractors that had been "parked" in this space. Other pieces of the wheel went through the skylight, the bottom of the flywheel pit was damaged, and on the generator side of the flywheel, a large piece weighing over a ton passed out through the roof, descending into a foundry about 250 ft. distant.

Both generators were so badly damaged that it will probably be cheaper to replace than repair them. On the d.c. machine the pulley was smashed, the field poles were battered and the end windings of the armature badly cut and torn. The rotor was yanked from the a.c. generator into the trench for the belts about 6 ft. nearer the engine. The bearing and pulley were smashed and the frame having broken away from its footings, lay on its side near the foundation, as shown in Fig. 6.

When the chief engineer reached the engine room, he found the engine still running. The governor and its belt were intact and apparently had the engine under normal control. As the steam pipe came up through the floor at the end of the cylinder, it escaped damage. The engineer immediately went to the boiler room and shut off the steam.

It is evident that the governor was not the source of the trouble. It had always given reliable service and continued to function after the accident. Either one of the generator pulleys might have broken, particularly the one attached to the a.c. machine, as it had no outboard bearing to support it. Suspicion however, lies with the shorter belt, as it had a couple of weak spots.

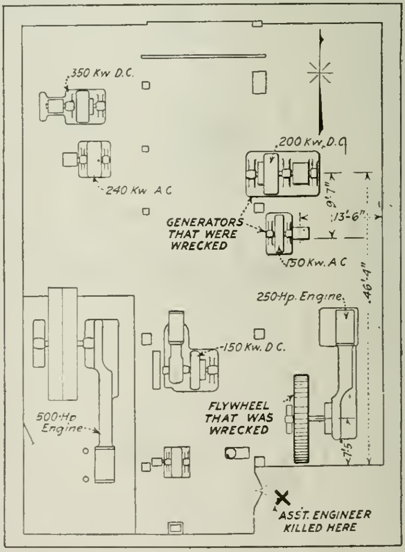


FIG. 1. PLAN OF ENGINE ROOM

One theory has been advanced, that the belt broke and a loose end wrapped around the pulley, yanking out the rotor and shaft from the a.c. generator. Then wedging under the longer belt it produced sufficient tension to break it and the pulley as well on the d.c. machine. The damage to the winding was probably caused by flying pieces from the flywheel. Subjected to a shock of this character and perhaps to increased speed after the load had been released suddenly the flywheel let go. The nature of the breakage would indicate centrifugal force as the immediate cause. The spokes all broke near the rim, the fractures indicating metal uniformly good. Pieces flew equally in all directions and with such force that an increase in speed was probable.

Another theory advanced was that the loose end of the belt might have knocked down something overhead such as the oil piping, which could have rested on the governor arm and have been automatically cleared during the wreck. It is positive that the oil piping and plenty of other things overhead were down after the accident, but it is likely that they were brought down by the flying pieces of the flywheel rim. The first theory seems more plausible. It is significant, however, that the time element between the breaking of the belt and the bursting of the rim must have been very short. Was it long enough for the engineer, after first noting trouble, to have reached the engine room door? This is a matter that should be given weight in attempting to analyze the cause of the accident.

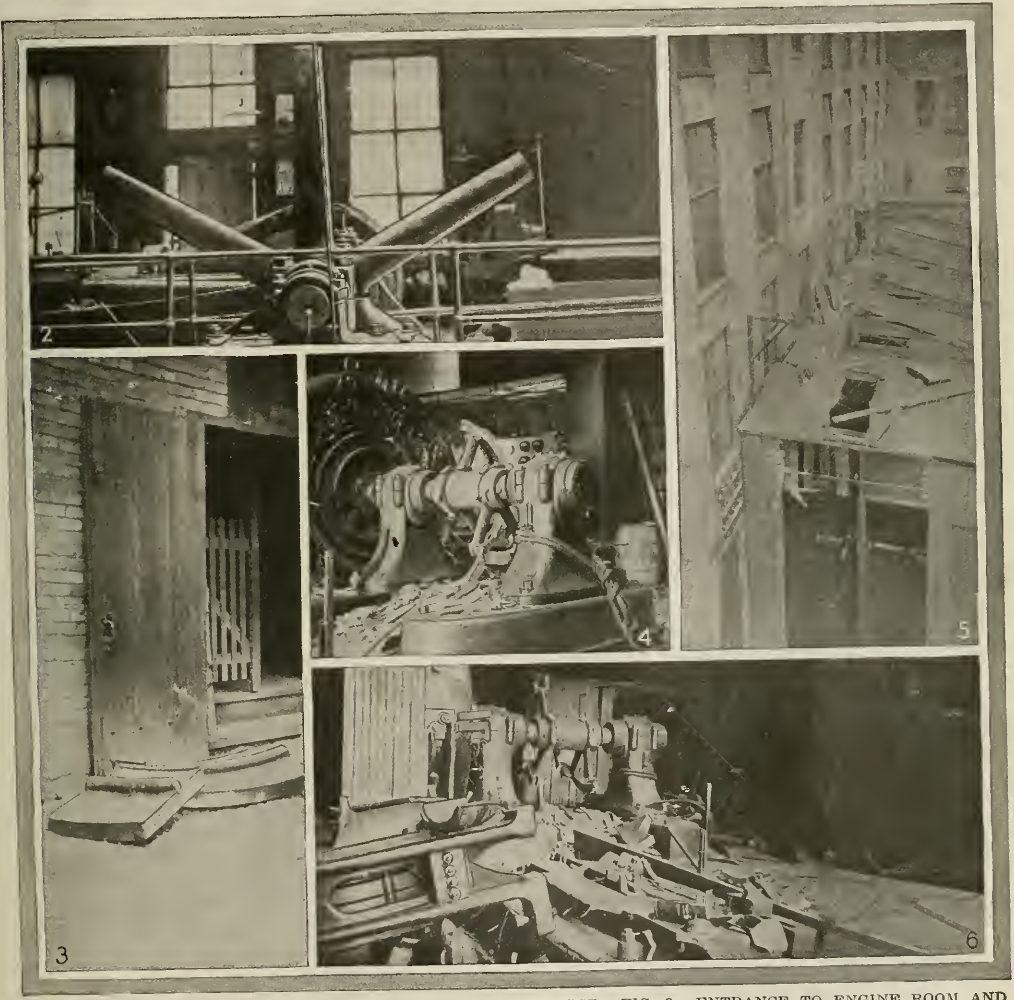


FIG. 2. SPOKES OF FLYWHEEL REMAINING AFTER RIM BURST. FIG. 3. ENTRANCE TO ENGINE ROOM AND PIECES OF RIM THAT KILLED ASSISTANT ENGINEER. FIG. 4. D. C. GENERATOR AFTER THE ACCIDENT. FIG. 5. HOLE THROUGH WALL AND ROOF. FIG. 6. A. C. GENERATOR LYING ON ITS SIDE AND SHAFT OF D. C. GENERATOR

Crab Short-Circuits Generator

A city of about 18,000 inhabitants located in San Domingo, West Indies, is lighted by a 150-hp. oil engine direct-connected to a 100-kw. generator.

The engineer of the plant is a tall, rawboned negro who was born in one of the British West Indian Islands.

Recently, the generator caught fire and the negro, instead of shutting down and subduing the flames, mounted a horse and rode a mile or more to ask the manager what should be done. When the manager arrived at the plant the flames had destroyed half of the generator coils.

Investigation revealed that a crab from a neighboring swamp had taken refuge in the generator frame and as soon as the movement of the machine had disturbed his sleep he had clamped his two claws into the insulation of two coils producing a short-circuit.

INSPECTION AND INSTALLATION OF ELEVATOR CABLES

By D. Alfred Manson.

INSPECTION and installation of elevator cables is one of the jobs that is up to the maintenance man of almost every building of any consequence today, therefore the method of inspecting, testing and installing these cables should be of interest.

After making a few minor repairs, I was told to make an inspection of the elevators in two large manufacturing buildings and to report in detail the conditions as found. Since that report was submitted, about ten years ago, I have been responsible for the maintenance and safety of these elvators. While I have been responsible for most all the different types of machinery about power plants, I have had but little experience outside of this plant on elevators. Therefore, my system of inspection and maintenance has been built up as an isolated one and is offered both for instruction to others and for criticism of those who are already familiar with methods in general used with this class of apparatus. In an editorial in *Power* on pumps, Feb. 4, 1919, the statement was made: "Examinations are necessary in order to detect what parts are wearing, how fast they wear, and to determine when to renew parts before they give out entirely and perhaps cause a shutdown." This statement is applicable to all mechanisms, but it should be given special emphasis with regard to elevators.

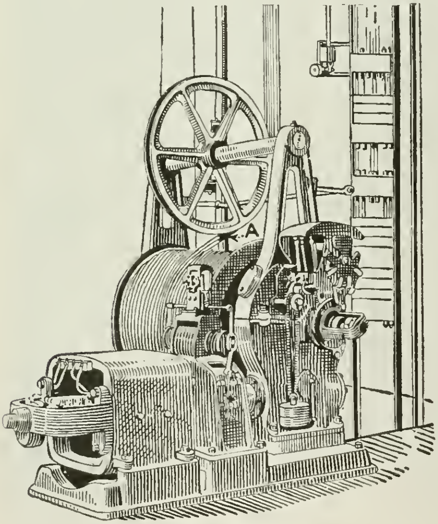
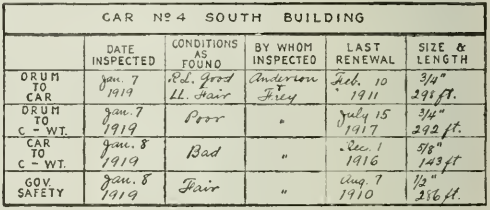


FIG. 1. DRUM-TYPE ELEVATOR MACHINE

Since the cables are of such importance, they should be given first as well as frequent attention. The cables in use in the plant in question range from $\frac{5}{8}$ in. to $\frac{7}{8}$ in. in diameter. They are of soft iron, having 6 strands and 19 wires per strand. I am frequently asked the life of our elevator cable. The question is not a simple one as one might think. First, the quality of the ropes is not uniform as a simple test will show. Take a foot or less of each sample of cable and heat about half its length to a good red heat and plunge it into cold water; if after cooling, the wires are stiff, they are not soft iron. If the ends of a few of the samples that were quenched are placed in a vise and then bent back and forth, the hard ones will break with the fewest bends and will probably crack earlier in use. Second, the conditions under which each pair of cables work are seldom like those of any other pair. Sheaves and winding drums of different sizes, reverse bends, where the cables come down around the vibrating sheave onto the drum, as at *A* Fig. 1, etc., have a marked influence on the life of cable. Brake adjustments are of importance too, and should be such that the car does not rebound, when stopped, but has just sufficient slide to bring it gradually to rest.



CAR Nº 4 SOUTH BUILDING					
	DATE INSPECTED	CONDITIONS AS FOUND	BY WHOM INSPECTED	LAST RENEWAL	SIZE & LENGTH
DRUM TO CAR	Jan. 7 1919	R.L. Good L.L. Fair	Anderson & Frey	Feb. 10 1911	3/4" 298 ft.
DRUM TO C - WT.	Jan. 7 1919	Poor	"	July 15 1917	3/4" 292 ft.
CAR TO C - WT.	Jan. 8 1919	Bad	"	Dec. 1 1916	5/8" 143 ft
GOV. SAFETY	Jan. 8 1919	Fair	"	Aug. 7 1910	1/2" 286 ft.

FIG. 2. CABLE-RECORD FORM

All these various conditions have a marked effect upon cable life. To illustrate, take the case in the plant in question where some $\frac{5}{8}$-in. cables are used from car to counterweight on one of the freight elevators. These cables have been in use ever since the elevators were installed, fifteen years ago, and are in good condition yet. On the other hand, a pair of $\frac{3}{4}$-in. cables installed on a passenger elevator from the winding drum to the main counterweight have had to be replaced in less than eleven months. It should be explained, however, that the freight was in use only eight hours a day, while the passenger elevators were in continuous use the whole twenty-four hours and for seven days in the week. Therefore, the length of time cannot be taken as a measure by which to determine the cable life; their safety must be determined after careful inspection made at the end of regular periods. I have adopted a three-month schedule and have arranged to record the conditions on a form, as shown in Fig. 2.

In order that the condition, such as good, fair, poor and bad, may have a fixed standard, the men are instructed to count the number of broken wires that are seen within a length of an inch and a half on any one strand. Cables showing none or one break per strand are rated good. Those having one break per strand with once in a while two wires per strand broken are rated fair. Cables having a large number of places where two wires are broken per strand and in some cases three wires broken per strand are rated poor. Those having a large numbers of places where three wires are broken per strand and some places where four to six wires are broken per strand are rated as bad. Whenever we can do so, we use a cable of each kind where two ropes are used side by side; that is, a right-lay rope and a left-lay rope, respectively. The abbreviations therefore in the table are intended to show that the right-lay rope *RL* is in good condition and that the left-lay rope *LL* is in only fair condition. The upper rope in Fig. 3 is a right-lay and the bottom a left-lay rope.

Cables reported bad are replaced with new immediately or later according to the several conditions which must necessarily apply to each individual cable, such as dangerously bad, bad but will probably last until other cables have been inspected, or will not need changing until such time as some important work will not be delayed by stopping the service, etc.

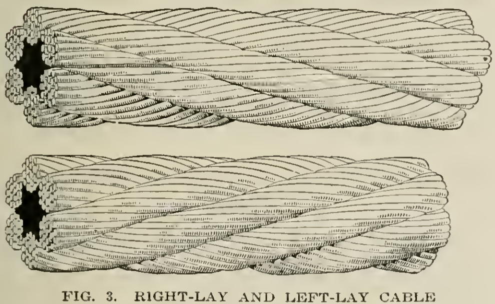


FIG. 3. RIGHT-LAY AND LEFT-LAY CABLE
Top—Right-lay rope. Bottom—Left-lay rope.

I am not familiar with the experience of others, but we have broken only four ropes out of 96 in use in the last ten years. Two others have stranded; that is, a strand or two have broken, but the rope did not part before the defective rope was detected and removed. On the other hand, we are getting about the limit of usefulness out of the cables as the following incident will show:

A contractor desired to guy one of his derricks and asked if we had any old cables? Some was pointed out to him, but he was cautioned that it was condemned and that if used he must assume the risk. He assumed the risk, guyed the derrick, broke the cable and fatally injured one of his men.

We are getting considerably longer life from our cables now than when the system of inspection was first installed. I attribute this mostly to the care in keeping the cables under equal tension or transferring the greater stress to the better rope of the pair. The ropes connecting between the drum and car and from drum to main counterweight may be easily adjusted by loosening the clamp inside of the drum on the tight or the poor cable, as the case may be, and letting out about one-half inch at a time until the desired tension is obtained in each.

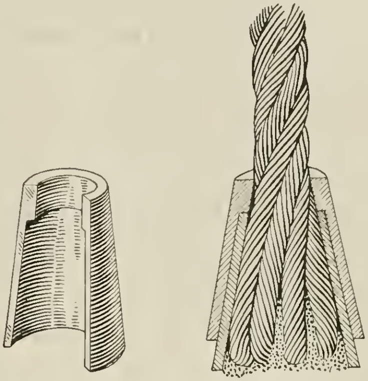


FIG. 4. SPECIAL THIMBLE FOR ADJUSTING CABLE TENSION

From the car to the upper or car counterweight, which is usually carried on a pair of cables smaller than the car or the main counterweight cables, there is no provision made for equalizing or adjusting the tension. It is seldom that a new pair of cables are cut exact enough to an equal length to have equal tension when the stress is put upon them. To overcome this defect, a special thimble, Fig. 4, was designed and put in use, which is slipped over the regular bell or thimble in the manner shown in the figure. This device will take up about $\frac{5}{8}$ in. and two may be used if found necessary.

Another simple instrument made and used by the men is shown in the Fig. 5. It was noticed that one of the men was depending upon his finger nails to detect cracks or broken wires, so taking the hint from him a scraper was made, as shown in the figure. The device was first tried out on greasy and dirty cable, also on smooth worn cable and found to be a perfect sleuth for picking up a broken wire. In use the sharp edge is drawn slowly over the cable with a light pressure placed on it with the hand. The sharp edge either enters the crack and stops the hand or gives a slight jump which attracts immediate attention. By the aid of these scrapers we are now able to inspect the cables in far less time and without the headache due to eyestrain.

Having decided which cables are to be removed, it becomes necessary to look into the stock on hand and order when short of any size. Most of the cables are approximately 300 ft. in length, therefore in ordering we obtain that amount or some multiple of 600 ft. on a reel to prevent waste and avoid carrying a large supply in stock.

A convenience at the time of removal is to have proper supports for the reel so that the cables may be unwound direct from reel into their place on the sheaves. A pair of strong horses similar to a carpenters sawhorse but with the legs on one end made shorter than those on the other end, as shown in Fig. 6, are used. Notches are shown on the top of the horse, which allow for swinging any size reel, and no time is wasted hunting blocking or old boxes. When about to remove the old ropes, it will be necessary to locate their ends on the drum in such a position that they can be worked upon. Therefore, placing the drum and at the same time having the proper amount of slack rope to work with will require a careful selection of the blocking to put under the counterweight or the car, depending upon which pair of ropes are to be renewed.

Ropes are always renewed in pairs, because a new one is larger than a used one, and if it were attempted to work a combination of new and old side by side, the larger rope would wind the faster and take all the stress, while the old one, or smaller rope, would develop more and more slack as the pair were wound around the drum. I have found it good practice to use cables of the same manufacture in a pair for this same reason. Otherwise the tension will not be the same throughout the whole car travel.

Having cut loose the old cables from the drum at the point where they pass through it, the turns on the drum are unwound and taken in a straight line to some convenient point where the position of their ends can be marked on the floor. Then the new cables, when they have been fastened into the thimbles at car or counterweight and the slack drawn over, are carried out to those same marks and, allowance being made for enough to fasten inside the drum, are cut off the length corresponding. In most cases there will be from two to two and one-half turns on the drums which is not unwound in use.

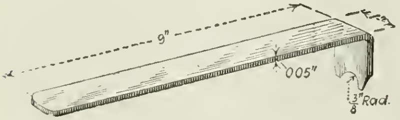


FIG. 5

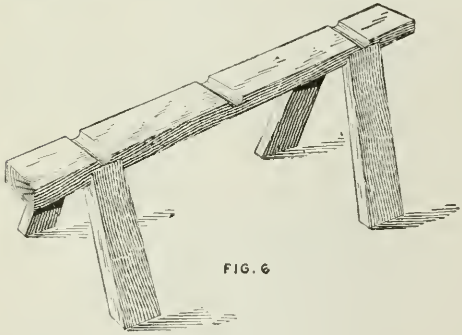


FIG. 6

FIGS. 5 AND 6. CABLE SCRAPER AND CABLE-REEL SUPPORTING HORSE

After marking the position of the ends of the old ropes, as described, all the strands except one should be cut away so that the remaining strand protrudes about three inches. This is best accomplished by first wrapping friction tape around the end where the strands are to be cut off, as indicated in Fig. 7. The remaining strand is then doubled back so as to form an eye or loop. The corresponding end of the new cable is treated in the same way, and the two are hooked together and thoroughly taped over. The old rope can now be used to pull the new one into place and will follow without catching upon any obstruction. Some surplus rope should be pulled over so as to give room to work while fastening the bells at the car or counterweight crosshead. When making up these ends, the bell is first slipped over the cable, small end first, and temporarily fastened back a couple of feet so as to be out of the way while making up the end ready to be incased by the bell. A fine iron wire or tape is wound about 3½ in. back from the end of the cable; the strands are opened out and the hemp core is cut off. The strands are then bent back on themselves in such a manner that the ends are all in the middle of the rope, as indicated in Fig. 8. After the bell is driven down over the upset end as far as it will go, some waste or other material is placed around cable at the small end of bell to form a dam, and molten lead is poured into the open mouth of the bell until it is full. The slack is now pulled back over the sheaves, the bells are brought into their proper bearings and the ropes are cut to length, as previously described. After cutting, the ends are passed through holes in the drum, the clamps are put on and the cables are given the load to see if they have equal tension; if not, they are adjusted with the clamps. A good finishing touch is a coat of raw linseed oil over the ropes.

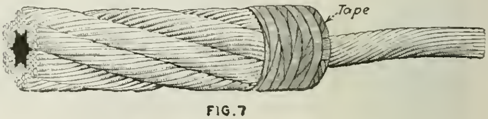


FIG. 7

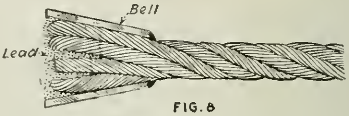


FIG. 8

FIGS. 7 AND 8. ENDS OF CABLES PREPARED FOR INSTALLATION

Fig. 7—Method of attaching two cables together. Fig. 8—End bell in place on cable.

Power Extension in the Monongahela Valley

Precautions to assure a sufficiency of electric power for the future, the culmination of which will mean an expenditure of a million dollars, are being taken by the Monongahela Valley Traction Company. The plan, as announced by President George M. Alexander, includes the doubling of the capacity of the power plant at Rivesville; the construction of new high tension lines to practically every point in the upper Monongahela Valley and the strengthening of the lines already established. Among the improvements to be started immediately are the installation of another large generator at Rivesville; the construction of a new line into Barbour county as far as Meriden and the construction of a 66,000-volt line from Clarksburg to Grafton and then from Grafton to Rivesville.

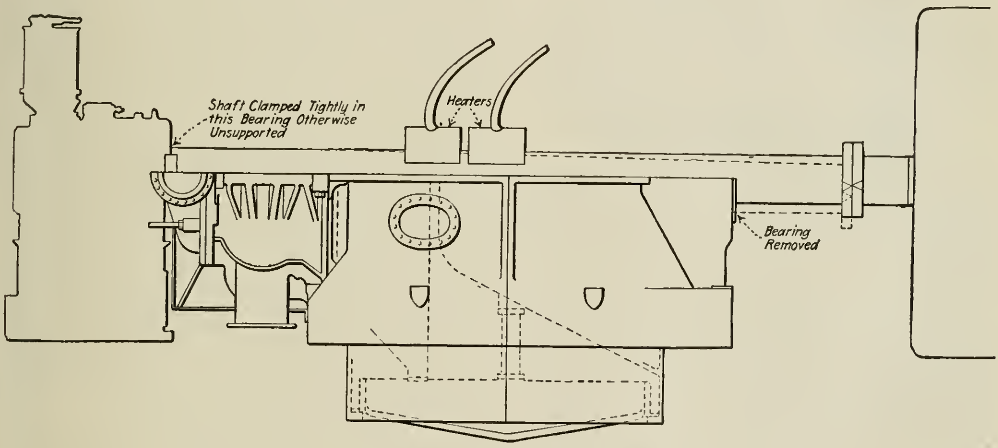
New improvement which will be put into effect this fall will be the extension of the 66,000-volt line which is now in operation between Rivesville and Hutchinson, on to Clarksburg and then east to Grafton. Following the completion of the line to Grafton, it will be extended down the Valley River to Fairmont.

Straightening Shaft of 45,000-Kw. Turbine

By E. E. Clock

IT WOULD seem that steel as used in the fabrication of modern machinery is not yet out of its swaddling clothes, judging by some recent performances in heat-treated steels and the gum-shoeing that prevails in the matter of its development. It would appear that the buyers of such machinery are entitled to more information on this subject. The erratic action of these steels in disks and shafts of steam turbines have rather upset some of the accepted formulas, especially in the performance of the steel under wide ranges of temperature found in turbine practice.

A short time ago a 45,000-kw. turbine became suddenly unbalanced by the loss of several blades on the last-stage disk and badly sprung the shaft. This shaft was straightened by a method that has never been made public, and being a distinct advance in the art, which in this case probably meant the saving of $60,000, a great opportunity to uphold the traditional generosity of the engineering profession was lost by not making it public.



SHOWING HOW THE SHAFT WAS SECURED AND HEATED TO STRAIGHTEN IT

The sprung shaft was stripped of its disks as shown and clamped tightly in the long bearing at the high-pressure end, with the bearing removed at the low-pressure end, leaving this end of the shaft entirely unsupported, the coupling to the generator being removed. To the end of the shaft was secured a scale marked in thousandths of an inch and registering the exact center of the shaft. Alongside of this scale was a target scale, also marked in thousandths and registering where the center of the shaft ought to be, showing and proving by rotating the shaft that it was out several hundred-thousandths. The shaft was placed with its stretched side up, which meant that its center mark on the scale on the shaft was below the center on the target scale. In this position we must take this view of the case: Here was a shaft sprung out of a true line and held so because the metal on the top of the shaft in its present position had become elongated or stretched and was holding the major part of the metal out of line against its natural tendency to come back into line; and if the stretched metal could have been removed, this shaft would almost straighten itself. Now, as this metal could not be removed, the next best thing would be to remove the stretch sufficiently to allow the fibers of the metal in the rest of the shaft to straighten out and just enough more to pull into line when cold against any tendency to remain permanently out of line.

This was accomplished in the following manner: Two airblast kerosene-oil burners, capable of quickly generating great heat, were placed on the top or stretched side of the shaft, the stretched portion of the metal being so quickly heated and expanded as to produce compression of the metal; in other words, the metal was upset. The burners were removed, and as the metal cooled, which it did in a few hours, the two scales began to come into line, and when the shaft had entirely cooled, the center marks on the two scales lacked but six thousandths of being line and line. Another slight heating in the same place resulted in bringing it four thousandths too far. This was corrected by the application of heat to the opposite side of the shaft, which resulted in the exact truing of this costly piece of machinery.

I was present when this machine was first brought up to speed after being reassembled; its performance was perfect and it has been in service since December, 1918.

In another case a shaft of a 2000-kw. turbine was sprung and was streightened by the old method of using force externally.

This shaft was treated by the application of heat evenly while it was kept turning in its bearing until it was again cool, force being applied the same as straightening a piece in the lathe. This method also was a success so far as the operation of the machine was concerned. Unfortunately, however, previous to the attempt to straighten the shaft an order was placed for a new one at $10,000. After the job of straightening proved all right an attempt was made to cancel the order for the new shaft and an offer was made to pay for the forward work that has been done on it. However, the builders of the machine, who had the order for the new shaft, protested that the repaired shaft was not safe to operate and so prevailed on the officials of the company owning the machine that they ordered the machine down until the new shaft should arrive.

Contrasting the two jobs, it would appear that if the first one was safe the second would surely be much more so. The first-mentioned machine is being carried on an insurance policy for $300,000.

Another recent turbine-shaft failure was that of a 75-kw. machine whose rotor, without exploding, overspeeded after releasing itself from its load by the breaking of the shaft, wrecking the stationary part of the machine, killing two men and finally coming to rest in a distant part of the room after performing some rather fantastic stunts about the engine room.

These three machines were each of a different make and widely different in capacity and were located in Detroit, Brooklyn and Staten Island in the order mentioned.

It is hoped that at coming meetings of the American Society of Mechanical engineers something will be brought out regarding this new art of straightening heavy shafts by the heat-treatment method.

The Limits of Thermal Efficiency in Internal-Combustion Engines

It was generally assumed by engineers as early as 1882 that the steam engine had reached its highest development so far as thermal efficiency was concerned, according to Sir Dugald Clark in a recent paper before the North East Coast Institute of Engineers and Shipbuilders.

In that year the highest thermal efficiency given by a steam engine was 12.7 per cent. of the total heat of the steam used. Assuming a boiler efficiency of 80 per cent. and a 90 per cent. mechanical efficiency, a 9.2 per cent. brake thermal efficiency was secured. But this is far below the record set by modern units.

The steam engine, by the use of triple expansion in cylinder engines, and the steam turbine, by the use of numerous expansions and intensified vacuum, utilized the available temperature range to such an extent that about the year 1914 the large steam turbine gave the indicated equivalent of 23 per cent. thermal efficiency of steam heat and 19.5 of brake-horsepower efficiency. This makes about 16.6 per cent. brake thermal efficiency calculated on the fuel beds of the boiler furnace.

Meanwhile the internal-combustion engine efficiencies have been raised to 35 and 37 per cent. indicated, and about 30 and 33 per cent. brake efficiency.

Considering both steam and internal-combustion engines as apart from the boiler, or the means of gas production as mechanism converting the heat in the working fluid into indicated work, gives the steam efficiency as 23 per cent. and the gas efficiency as 35 to 37 per cent. If the boiler is included, the steam indicated efficiency falls to 19.6 per cent., and when the gas-producer efficiency of 85 per cent. is included, the gas engine indicated efficiency falls to between 29.8 and 31.4 per cent. and the brake efficiency to between 26.8 and 28.4 per cent. The table shows the comparison:

The law of similar structures and the experience of high-speed gas engines for aviation purposes all point to ultimate success in the construction of large gas-engine units composed of many cylinders geared to a common shaft. The writer speaks of a discussion of the principles of such engines with Sir Charles Parsons, and it was agreed that multiple-cylinder units of 10,000 b.hp. on a single shaft are quite capable of practical construction on these lines. It requires only the design and development of a unit cylinder of about 250 b.hp. capacity at 250 r.p.m., and four 12-cylinder engines of this type could readily produce the required power in one shaft. Large-cylinder engines, such as had been developed in Germany before the war, do not permit of very large unit powers, except at an extravagant waste and cost. Such large-cylinder engines have no chance of competing with the steam turbine in the production of large units. At present the reciprocating gas engine is superior in fuel economy to the steam turbine, but it is probable that the large steam turbine may still improve in thermal efficiency. It is much to the benefit of both steam and internal-combustion industries that this rivalry should continue to exist, the steam-turbine engineers attempting to increase thermal efficiency and the interal-combustion engineer, the power magnitude of unit and thermal efficiency simultaneously.

STEAM AND INTERNAL-COMBUSTION ENGINE THERMAL EFFICIENCIES IN 1882 AND 1914

	Steam Engines		Internal-Combustion Engines	
	Thermal efficiency to heat of of steam supplied to engines		Thermal efficiency to heat of of gas supplied to engines	
Year	Indicated	Brake M.E. 90%	Indicated	Brake M.E. 90%
1882	12.7%	11.4%	16.0%	14.0%
1914	23.0%	19.5%	37.0%	33.4%
	Thermal efficiency to heat of coal supplied to boiler. Boiler efficiency, 85%		Thermal efficiency to heat of of fuel supplied to gas producer Gas producer efficiency, 85%	
1882	10.8	9.7	13.6	11.9
1914	19.6	16.6	31.4	28.4

There is a common error among some engineers as to the enormous heat loss in the cylinders, especially of a slow-running gas engine. The actual heat losses are much smaller than is generally supposed.

The following mean balance sheets of three separate indicator cards, taken by this method for determining heat loss and specific heat, show quite clearly that the heat flow during explosion and expansion is relatively low. The balance sheet is as follows:

MEAN BALANCE-SHEET

	Per Cent.
Heat flow during explosion and expansion	16.1
Heat contained in gases at end of expansion	49.3
Indicated work	34.6
	100.0

As here shown, the larger part of the heat loss is that discharged in the exhaust gases from the cylinder of the engine.

From the values it is evident that no great improvement in thermal efficiency would be obtained were the whole 16 per cent. heat loss of explosion and expansion entirely suppressed. Then 16 per cent. of 0.37 indicated efficiency would give only an addition of 5.9 per cent.; that is, the 37 per cent. would be raised at most to 43 per cent. This total suppression of heat loss is obviously impossible, but considerable improvement may be obtained by raising the compression ratio to 10. Here the air standard efficiency becomes 0.6, and assuming similar heat losses, $0.6 \times 0.7 = 0.42$; that is, 42 per cent. indicated thermal efficiency is practicable without reducing the heat loss to the piston and inclosing metal walls. In a multiple-cylinder engine mechanical efficiency may be taken as 90 per cent., so that the greatest probable brake efficiency would be 43 × 0.9, or 38.7 per cent.

Compounding in cylinders has been attempted many times, but the increased heat loss of transfer from high-pressure to low-pressure cylinder has rendered the gain in efficiency too small to be worth the additional weight and complication of the engine. There appears to be only one method open to further increase of heat economy in a practicable way, and that is by using regeneration of heat in some form. Utilization of the waste heat of the water jacket, and the heat of the exhaust gases, to raise steam, has become considerable. About 2.5 lb. of steam per brake horsepower have been obtained from the exhaust-gas heat of large gas engines. Many installations of this kind have been at work for about fifteen years. The steam generated has not been used for producing motive power, but for boiling and heating operations in chemical factories. If in such large installations the steam had been used in a high efficiency Parsons steam turbine requiring 10 lb. of steam per brake horsepower, then 25 per cent. would have been added by steam expansion to the brake power obtained by internal combustion.

In an engine giving 39 per cent. brake thermal efficiency, there remains 61 per cent. of the original heat of the engine part of which could be used to raise steam. Of these 61 heat units 4 are partly lost by engine friction and about 10 by radiation, so that the heat remaining for use is 61 minus 14, or 47; that is, 47 per cent. of the original heat. In a boiler of 80 per cent. efficiency this would enable 37.6 per cent. of the original heat of the gas to be delivered to a steam engine. Used in a Parsons steam turbine of 18 per cent. thermal efficiency, brake power to steam heat, would give an addition of 47 × 0.18, or 8.46; that is, the brake efficiency of one regenerative gas and steam engine would rise from 39 per cent. to slightly over 47 per cent. It may be taken that high-compression engines in large units with steam turbine addition might raise the brake efficiency to 47 per cent.

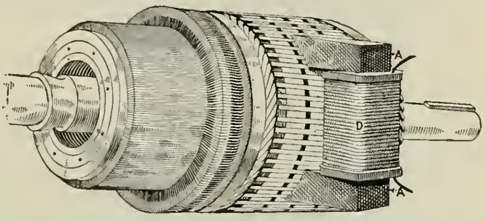
In considering the Diesel type, undoubtedly much further study and experiment are desirable. Little study has been given to Diesel indicator diagrams and less to the conditions of heat flow and exhaust loss. These should be very fully determined. Optical indicators should be used, and zigzag diagrams should be taken to determine specific heat and heat loss in the cylinder. Diesel efficiency is undoubtedly high, but by no means higher than can be obtained from constant volume or explosion gas engines when designed and built for high explosion pressures. The great problem in all Diesel engines is that of the formation and projection of all sprays. The spraying at present dominates the efficiency value obtainable.

The air standard efficiency shown on the Diesel type of diagram is 0.56. Assuming heat losses similar to those in explosion gas engines, the indicated thermal efficiency to be expected in the working engine would be $0.56 \times 0.7 = 39.2$; and assuming, as before, a mechanical efficiency of 90 per cent. in a multiple-cylinder engine, the brake thermal efficiency would be $39.2 \times 0.9 = 35.3$ per cent. With a compression ratio of 15, however, which is quite practicable in a Diesel engine, the air standard efficiency would be 0.62, and the indicated efficiency using the factor 0.7 would be 43.4, giving at 90 per cent. mechanical efficiency a brake thermal efficiency of 39 per cent. It is probable that in the case of Diesel engines the conversion factor will prove to be higher than 0.7 as the conditions of heat flow from fluid to cylinder are more favorable than in the explosion engine. Accordingly, it is to be expected that a combined high-compression and regenerative steam cycle will give brake efficiencies approximating 50 per cent., as in the case of the explosion engines.

Test Coil Burned Out

By E. C. Parham

For indicating the presence of short circuits in connected armature windings, some repair shops use a laminated iron shoe *A*, as shown in the figure, on which a coil *D* is wound. On applying the shoe to an armature as indicated with the coil connected to a source of alternating current and exploring with a strip of thin iron in the hand around the core while the current is on, the presence of a short-circuit will be indicated by the vibrating of the strip when it is held over one leg of the faulty coil, the other leg of which is within the influence of the magnetic field of the test shoe.

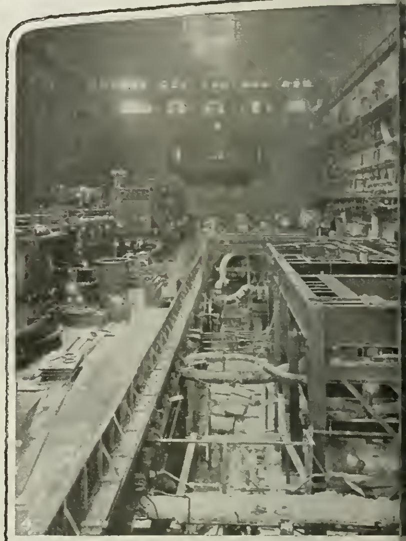


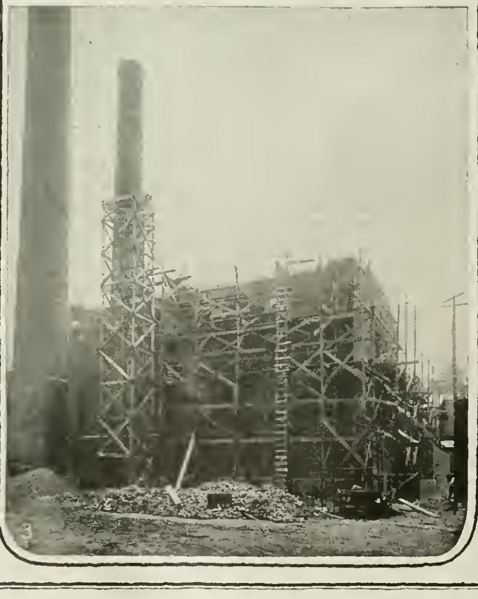
TEST COIL IN PLACE ON ARMATURE

If an alternating-current electromagnet, the coil of which is intended to operate on a complete iron magnetic circuit, is subjected to full voltage and normal frequency with the magnetic circuit open, the current flow will be abnormal and the coil probably will be burned out if the current is left on for any length of time, unless a fuse or a breaker opens the circuit. Therefore when using an outfit such as that indicated in the diagram, it is important that the shoe be close to the armature before turning on the current. The result of failing to observe this precaution is illustrated by the following:

A testing shoe was improvised from an old motor polepiece onto which had been wound a coil. Two coils had been burned out but not before the usefulness of the shoe had been demonstrated. Assuming that the whole reason of the failures was insufficient space to put a proper winding, it was proposed to get special iron stampings from which to make a shoe that would permit of winding on a coil of a greater number of turns. However, about this time it was discovered that the cause of the coil burning out was due to allowing it to remain connected to the circuit when the shoe was not in contact with an armature core which caused the inductance of the coil to be low, consequently the current to be abnormally high. With due precautions that the electric circuit was closed only when the magnetic circuit was closed a similar coil gave no trouble.

SOME VIEWS OF





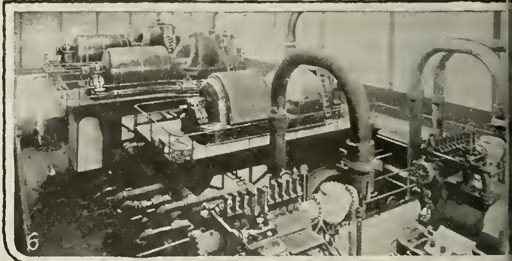


Fig. 1—Williamsburg (Pa.) Station, Penn Central Light & Power Co., Day & Zimmermann, Engineers.

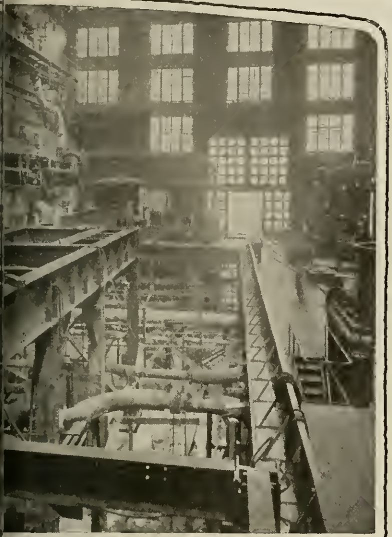
Fig. 2—Front Street Station, Erie (Pa.) Lighting Co., Day & Zimmermann, Engineers.

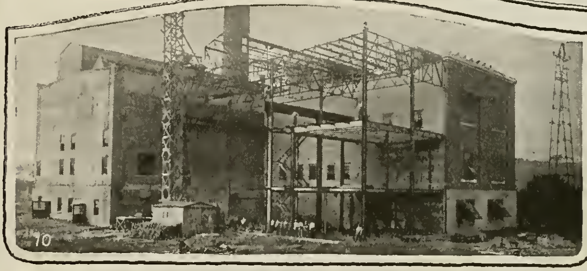
Fig. 3—Nicholas & Shepard Co., Battle Creek, Mich., Westinghouse, Church, Kerr, Engineers.

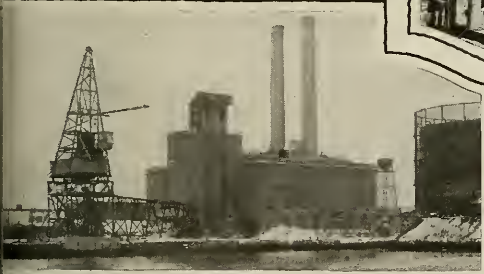
Fig. 4—Foundations for New 35,000-kw. Turbines, Waterside No. 2 Station, New York Edison Co.

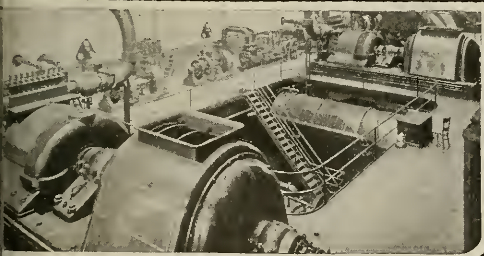
Fig. 5—Lowellville (O.) Station, Mahoning & Shenango Ry. & Lt. Co., Stone & Webster, Engineers.

NEW POWER PLANTS









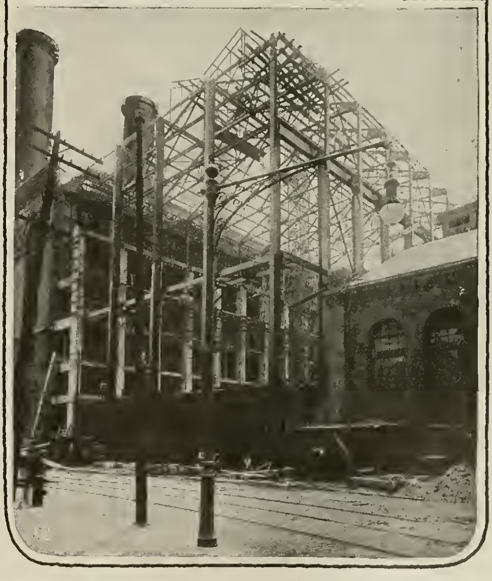


Fig. 6—New Bedford (Mass.) Gas & Edison Lt. Co., Stone & Webster, Engineers.

Fig. 7—Looking East, Waterside No. 2 Station.

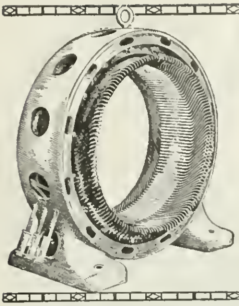
Fig. 8.—New Bedford Gas & Edison Light Co.

Fig. 9—Mahoning & Shenango Ry. & Lt. Co.

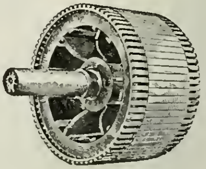
Fig. 10—Penn Central Lt. & Power Co.

Fig. 11—Williamsburg Annex, Brooklyn Rapid Transit Co., Thomas E. Murray, Engineer.

Fig. 12—Williamsburg Annex, Front View. Two 35,000-Kv.-a. Turbines, Three Units Going in Later.



The Rotating Magnetic Field in Alternating-Current Motors

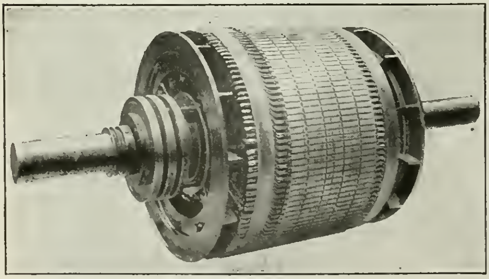


by
F. A. Annett

There are in general use two types of polyphase alternating-current motors; namely, induction and synchronous. Both operate on the well-known revolving magnetic-field principle. It is the purpose of this article to explain how the revolving magnetic field is produced.

INDUCTION motors are made up of two major parts, the stator and the rotor. The stator, shown to the left in the headpiece, is the stationary element and has placed in slots, in the inner periphery of the core, coils which are grouped into a winding connected to the power circuit. The rotor of the squirrel-cage type is built up of a laminated iron core, slotted on its outer periphery. In these slots are placed copper bars which are connected to rings at each end of the core, thus forming a closed winding, as shown to the right in the headpiece. In the wound-rotor type the revolving element is wound with an insulated winding and connected to slip rings, Fig. 1, similar to the winding used on a revolving-armature-type alternator. The slip rings are connected to an external resistance used for starting and to control the speed of the motors. The stator winding is the same for both types of machine.

The induction motor is differentiated from the direct-current motor in that where the latter is supplied with current from an outside source to both its armature and field windings, in the induction motor the current is supplied to its stator winding only. Then how does the induction motor operate? is the question that naturally arises. This might be answered by saying, "On the same fundamental principles as the direct-current motor"; namely, the reaction between the magnetic field set up about the conductors on the revolving element due to the current flowing in them and the flux from the polepieces, the polepieces in the induction motor being the stator. The fundamental difference between the two machines is in how the current is set up in the rotor winding of the induction motor, which has no electrical connection whatever with the stator winding. In what follows in this and a subsequent article, an explanation will be given of how current is induced in the rotor bars of an induction motor and how this in turn reacts upon the flux in the stator to produce rotation.



WOUND ROTOR FOR INDUCTION MOTOR

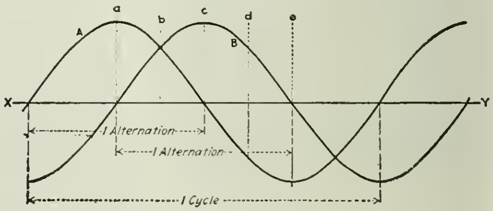


FIG. 2. CURRENT OR VOLTAGE CURVES OF A TWO-PHASE CIRCUIT

The explanation of the revolving magnetic field can in general be most easily given by utilizing a two-phase circuit, the conditions of which may be represented by the curves *A* and *B*, Fig. 2. Instead of using a smooth-bore stator with a uniformly distributed winding, a field structure will be employed similar to that used in a direct-current machine (see Figs. 3 to 7). In this structure there are eight polepieces, four of which are linked together by the winding *A* and four by winding *B*, representing the conditions in a two-phase motor. Although there are eight polepieces, it will be seen in the following that the magnetic lines combine in such a way as to form but four poles. In this discussion it will be assumed that the current is in step with the voltage, although this is not true in practice; it nevertheless has no effect upon the production of the rotating magnetic field.

Consider the windings *A* and *B*, Fig. 3, connected to a two-phase circuit, and let curve *A* and *B*, Fig. 2, represent the voltage applied to the windings, consequently the current flowing in them. At the instant *a* on the curves, Fig. 2, it will be seen that the voltage in phase *A* is at a maximum value, while that in *B* is at zero, consequently the current in winding *A*, Fig. 3, will be at a maximum value. If the current is considered flowing in winding *A* in the direction of the arrowhead, poles A_1 to A_4 will be magnetized of a polarity as indicated. Since the current is at a maximum, the magnetic field will also be at a maximum value and will divide at the center of the N poles, pass into the rotor core back into the S poles, as illustrated in the figure. This division of flux at the pole faces is similar to that in the bar magnet, Fig. 8. Here the flux also divides at the center of the N pole and passes around through the air to the S pole.

Next consider the condition in the circuit represented by the instant *b* on the curves, Fig. 2. At this instant the current in *A* has decreased and that in *B* increased until it is the same value in both. Applying this condition to the motor windings, the current will be one-half maximum in each and in the same direction as in Fig. 4. This arranges the eight poles into four groups, each containing two like poles. Like poles repel, therefore all the flux from any N pole will pass into the rotor core and go to the adjacent S pole, as shown in Fig. 4. This condition is illustrated with bar magnets in Fig. 9. Here the two similar magnets *A* and *B* are placed so that their like poles are adjacent to each other, and since like poles repel, the flux from one N pole will be pushed away from that of the other, consequently giving a distribution to the lines of force similar to that shown in the figure. Comparing Figs. 3 and 8 with Figs. 4 and 9, it will be seen that where the centers of the magnetic fields are at the centers of *A* polepieces in Figs. 3 and 8, the centers of the magnetic field are located between *A* and *B* polepieces in Figs. 4 and 9. In other words, the center of the magnetic field has been caused to move one-half the width of a polepiece.

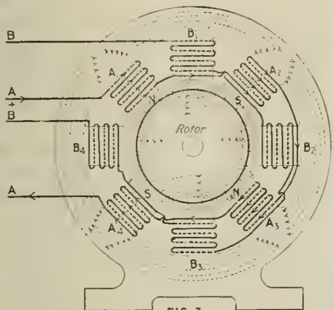


FIG. 3

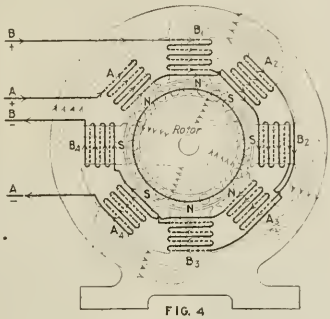


FIG. 4

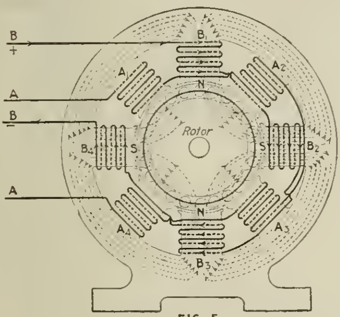


FIG. 5

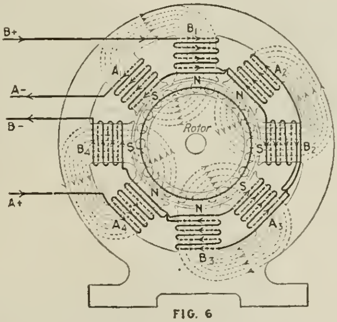


FIG. 6

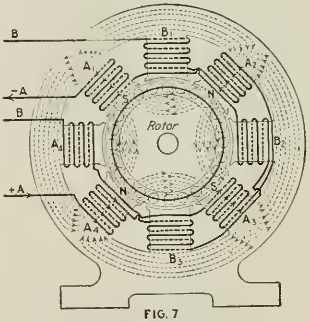


FIG. 7

FIGS. 3 TO 7. SCHEMATIC DIAGRAMS OF A TWO-PHASE INDUCTION MOTOR

At the instant *c*, Fig. 2, the current in phase *A* has decreased to zero, and that in phase *B* has increased to a maximum value, consequently the current in the motor's winding *A* will be at zero value, while that in winding *B* will be at a maximum value. This condition is illustrated in Fig. 5. The flux in the *A* polepieces has become zero, while that in polepiece *B* has reached a maximum value, and the center of the magnetic field is at the center of the *B* polepieces. This condition is the same as if bar magnet *A*, Fig. 9, was removed. Then the flux distribution would be as indicated in Fig. 10, which shows the center of the magnetic field shifted to the left from between *A* and *B* magnets, in Fig. 9, to the center of the *B* magnet, Fig. 10. Again, the center of the magnetic field has been caused to shift one-half the width of a polepiece.

Returning to the curves *A* and *B*, Fig. 2, and considering instant *d*, it is found that the currents in *A* and *B* phases are again of the same value. But curve *A* is below the line *XY*, indicating that the current in phase *A* is flowing in an opposite direction to that in phase *B*. This condition is illustrated in Fig. 6. Here it will be seen that the direction of the current in winding *A* is reversed from that shown in Figs. 3 and 4, but the current in *B* is in the same direction as in Figs. 4 and 5. This has reversed the polarity of the *A* polepieces, and now the poles of *A* phase that had *N* polarity in Fig. 3 have become S poles in Fig. 6 and vice versa. However, this has again brought like poles adjacent, and the flux distribution will be as shown. This is a condition similar to what would have been the case if magnet *A*, Fig. 9, had been taken from the left-hand side of the *B* magnet and placed on the right-hand side as in Fig. 11. Again the center of the magnetic field has shifted, this time from the center of the *B* polepiece to between *B* and *A* polepieces.

At instant *e* on the curves, Fig. 2, the current in phase *B* has decreased to zero, and that in phase *A* has reached a maximum value. This is a condition similar to that existing at instant *a*, excepting that the direction of the current in phase *A* is reversed. Consequently, the current in the motor winding will be zero in phase *B* and at a maximum value in phase *A*, as in Fig. 3, therefore the magnetism in pole *A* will be at a maximum and in *B* zero value, Fig. 7. This will give a flux distribution the same as that in Fig. 3, but of a reverse polarity. The center of the magnetic poles has now shifted from between the *B* and *A* poles.

Fig. 6, to the center of the A poles as shown in Fig. 7. A similar condition would be obtained in Fig. 11 if magnet B is removed as in Fig. 12. There the center of the magnetic field has shifted from between the B and A magnets to the center of magnet A.

Comparing Fig. 8 with Fig. 12, it is seen that the center of the magnetic field has shifted from the center of magnet A, Fig. 8, shown in dotted line in Fig. 12, to the center of magnet A, shown in full lines, Fig. 12. Similarly in Figs. 3 to 7, the magnetic field has shifted from the center of magnets A_1 and A_3, maximum value N poles, to the center of A_2 and A_4, maximum N poles; likewise the S poles have shifted from A_4 and A_2 to A_1 and A_3.

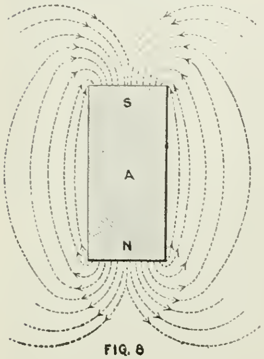


FIG. 8

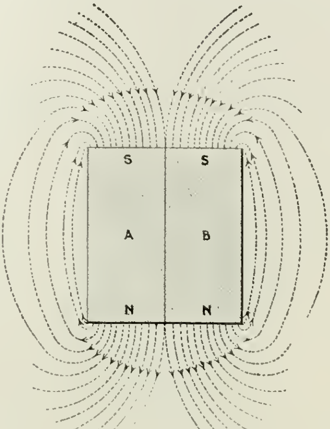


FIG. 9

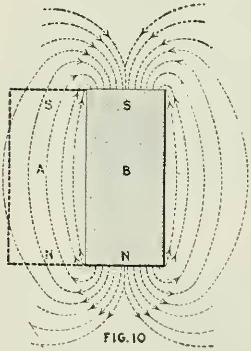


FIG. 10

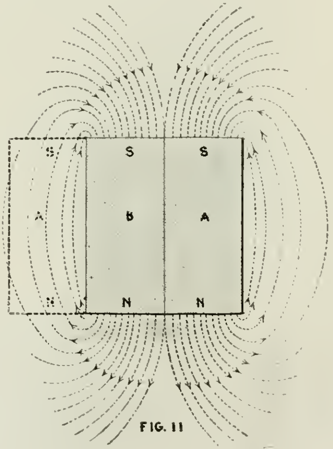


FIG. 11

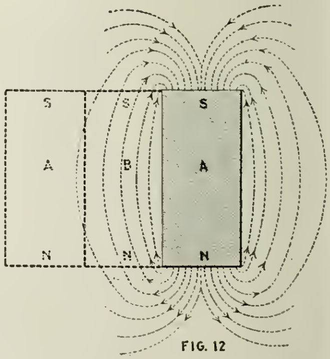


FIG. 12

FIGS. 8 TO 12. ILLUSTRATES HOW THE MAGNETIC FIELD IS MADE TO REVOLVE IN AN INDUCTION MOTOR

Referring to the curve, Fig. 2, it will be seen that the current in each phase has passed through the equivalent of one alternation. At *a* the current in phase A is at a maximum, and that in phase B is at zero value; likewise at *e* phase A is again at a maximum value, but in this case in the opposite direction, and phase B is at zero. From this it is evident that for one alternation the magnetic field in the motor shifts one pole, then for one cycle (two alternations) the magnetic field will shift two pole spaces. In other words, for each cycle that the current passes through, the magnetic field will shift around the one pair of poles. Now, if the motor was connected to a 60-cycle circuit—that is, a circuit in which the current makes 60 complete reversals per second, or 120 alternations per second—the number of revolutions made by the magnetic field in one second would equal the cycles divided by the pair of poles. In our problem the induction motor has four poles, or two pairs, therefore the speed per second of the magnetic field for a 60-cycle circuit will be $\frac{60}{2} = 30$ revolutions. Looking at this problem another way, for one cycle the field will shift two pole spaces; therefore, for two cycles, in a four-pole machine, the field will shift four pole spaces or make one revolution: that is, two cycles is equivalent to one revolution. Then for 60 cycles the field will make $60 \div 2 = 30$ revolutions, which checks with the value obtained in the foregoing.

In one minute the speed will be 60 times that for one second, or in this case, $30 \times 60 = 1800$ revolutions per minute. If S equals the revolutions per minute, $\frac{P}{2}$ the number of pairs of poles, and *f* the frequency, the cycles per second, then the revolutions per minute S—that is, the speed of the magnetic field—is $S = \frac{120 f}{P}$. Substituting the value 60 for the frequency (cycles per second) and 4 for the number of poles gives $S = \frac{120 \times 60}{4} = 1800$. If the frequency were only 25 cycles per second, $S = \frac{120 \times 25}{4} = 750$ revolutions per minute. From this it will be seen that if a 4-pole motor is connected to a 60-cycle circuit, its magnetic field will revolve at 1800 revolutions per minute, and on a 25-cycle circuit, 750 revolutions per minute.

The formula may be transposed to read $P = \frac{120f}{S}$ to find the number of poles when the speed and frequency are known, and $f = \frac{PS}{120}$ to determine the frequency (cycles per second) when the number of poles and speed are known. If the frequency equals 60 cycles per second and the speed 1800 r.p.m., then $P = \frac{120 \times 60}{1800} = 4$ poles. This is what it should be for the machine in the figures. On the other hand, knowing the number of poles to be 4 and the speed to be 1800 r.p.m., frequency $f = \frac{4 \times 1800}{120} = 60$ cycles per second. From this it is evident that there is a fixed relation between the number of poles and the speed of the revolving magnetic field of an induction motor and the frequency of the circuits to which it is connected. From this it is evident that there is a fixed relation between the number of poles and the speed of the revolving magnetic field.

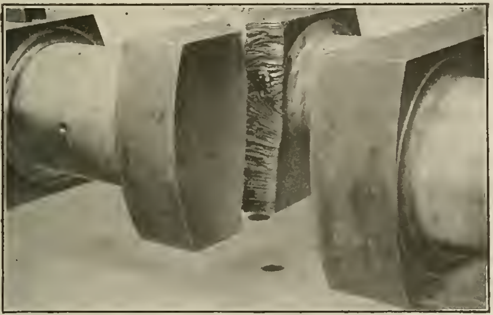
An Unusual Welding Repair Job

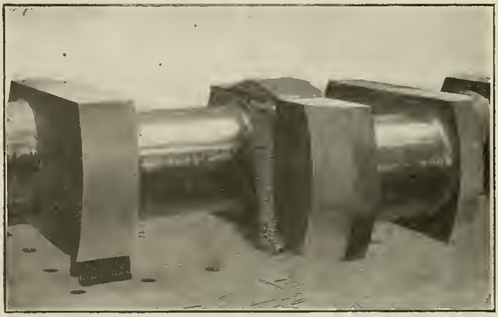
An unusual welding repair job, which required skill to successfully handle, was that of a six-ton crankshaft broken through the web, as shown by Fig. 1, which view was taken after the surface of the break had been chipped preparatory to welding.

This shaft was part of the equipment of the Houston Ice Brewing Co., Houston, Tex., but as repairs could not be made in that section, the broken shaft was shipped to the Jersey City plant of the Vulcan Iron Works, where it was electrically welded by the Wilson plastic-arc process.

The greatest difficulty was insuring proper alignment of the shaft at the conclusion of the work. The shaft was clamped to the table, and lined up as shown in Fig. 3, and the welding proceeded after the metal at the break had been chipped out to insure a clean surface for the added welding metal to fuse with.

The finished job is shown in Fig. 2. The shaft was then tested in a large lathe and found to be true from end to end.





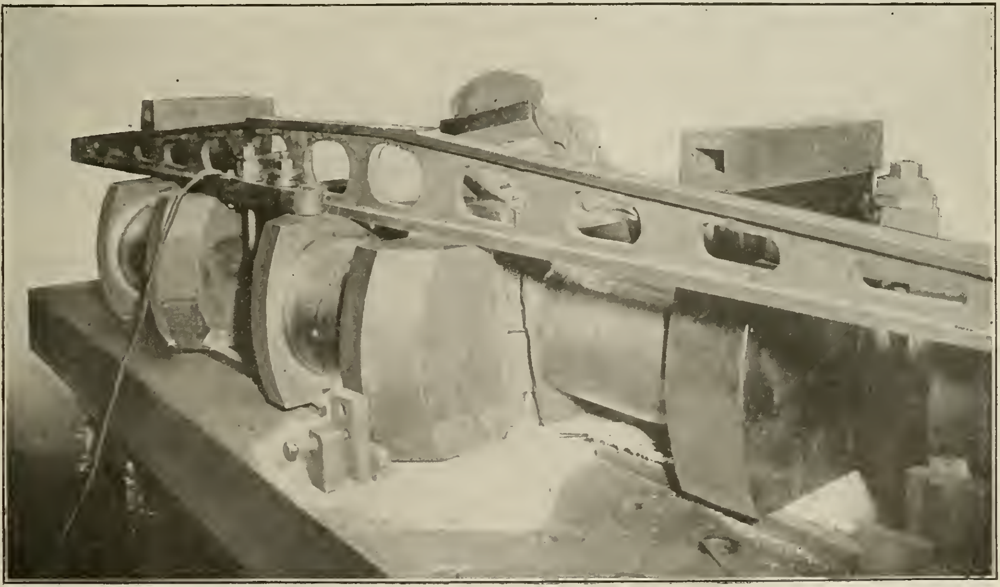
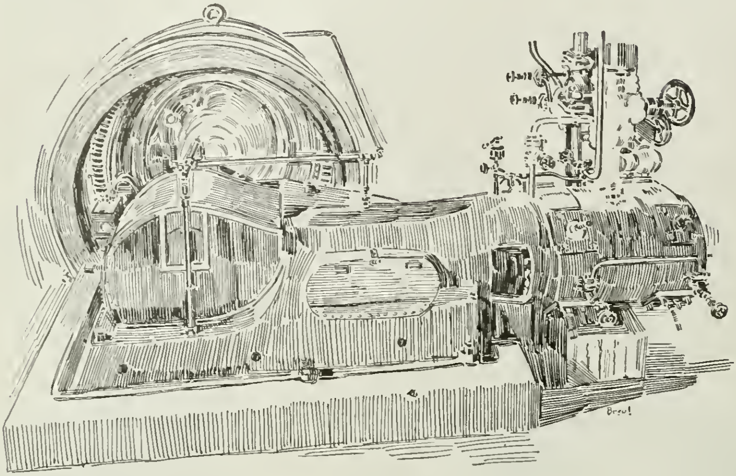


FIG. 1. CHIPPED SURFACE OF BREAK, BEFORE WELDING. FIG. 2. THE COMPLETED JOB BEFORE TRIMMING.
FIG. 3. THE SHAFT LINED UP AND CLAMPED TO THE TABLE; WELDING IN PROGRESS

FUNCTIONS OF AMMONIA COMPRESSOR



By

John E. Starr,

CONSULTING ENGINEER

NEW YORK

Rid the mind of the idea that the compressor sucks the gas into its cylinder from the evaporating coils; it comes in under pressure, and the higher the pressure the better. Wet compression is no help to power consumption per ton capacity. Watch the jacket water temperature.

WE have seen that the expansion system, whether it be pipes or a cooler, may be likened to a steam boiler as it generates gas or changes a liquid to a gas by boiling on adding heat to it at a low pressure.

The suction pipe of the evaporator should be regarded as one regards the pipe carrying steam to the engine.

Rid the mind of the idea that the compressor "sucks" the gas from the evaporator. Consider it the other way; get it firmly fixed in the mind that the heat added in the evaporator boils a liquid into a gas just as heat boils water into steam and that this gas is delivered to the compressor with some pressure and helps to run it.

For example, suppose the boiling point in the evaporator is about zero. It will boil the liquid into a gas at a pressure of about 30 lb. abs. or 15 lb. gage and deliver it to the suction side of the compressor at that pressure. If the head pressure is 175 lb. above no pressure, or 160 lb gage, the net pressure is 175 — 30 = 145 lb. or by gage 160 — 15 = 145 pounds.

The steam engine or other motive power then has to compress the gas from 15 lb. gage to 160 lb. gage in order to put it in shape to condense back to a liquid having a temperature of about 84 deg. F. in this case. If the cooling water was zero or a little below, this power would not have to be applied, for the gas flowing to the compressor at zero would condense back to a liquid at 15 lb. gage pressure and could be boiled again.

But there is no water at zero. If there was, no compressor would be needed there. There may be water that can be heated to about 84 deg. F. So the gas at zero must be made to condense at 84 deg. This can be done by adding a little heat or power to the power that is already in the gas and then, by taking some heat out of it, condense it to a liquid at 84 deg. So heat or power is added in this case, by 145 lb. pressure in addition to the 15 lb. gage pressure it already has, and so 160 lb. gage pressure is produced at which the gas will condense to a liquid at 84 degrees.

But in compressing the gas heat is added to it, so that while it has a pressure that will cause it to condense at 84 deg. F., it will have a temperature much above 84 deg. at the start. This heat is called "superheat," meaning that the gas is heated above its condensing temperature. This superheat has never been saved. Theoretically, it can be saved, but the apparatus to save it would not pay except in an enormously large machine, so this heat is rejected and sent away by radiation and in the cooling water.

Not only does the heat of compression heat the gas itself, but the heat of the gas is conveyed to the cylinder walls. The heat from these walls in turn heats the incoming gas that has been driven by the evaporator to the compressor. This expands the incoming gas so that it occupies a little more space per pound, or any unit weight, than it did at the temperature at which it was boiled out; or in other words, if a pound of ammonia at zero was boiled well, the resulting gas would occupy 9.18 cu.ft.; but as this gas becomes expanded by cylinder heating, it would occupy from 11.5 to 12.2 cu.ft. in the compressor. So to cause the evaporation of 1 lb., or 9.18 cu.ft., boiled at zero one really has to displace from 11.5 to 12.2 cu.ft., and to add 145 lb. pressure to it to condense it at 84 deg. F. This is called volumetric efficiency, which simply means that the compressor displaces only from 75 to 80 per cent. of the weight of liquid changed to a gas at, say, zero. It is true that by injecting a little liquid ammonia at the compressor one can take out some of this superheat; but it must be remembered that this liquid in order to cool, must also be changed to a gas and that this gas must be handled by the compressor. Therefore "power per ton" has not been helped much by "wet" compression. Nor can much be expected from water jackets. In a single-acting machine the gas enters colder than the water and gets warm only by heat transferred to it after the discharge valve has opened, so about all the jackets do is to help out the condenser. In a double-acting machine the conduction of the iron brings out about the same results, and the principal advantage in wet compression lies in the fact that it lowers the temperature of the gas somewhat while in the compressor and keeps the oil and the stuffing-boxes cooler than they would be otherwise.

It was shown clearly in the celebrated Eastman Kodak tests that it made little difference in horsepower per ton whether the water was running in the jackets or not, and it was also shown that the water was cooled instead of heated at the inlet side of the compressor. So best results have been obtained by so feeding the liquid that the gas is all boiled out and comes to the compressor only a little above the temperature at which it boiled.

It should come to the compressor a little above the temperature at which it was boiled so as to be sure that no liquid enters the compressor. It is easy enough practically to keep it, say, 5 to 8 deg. above the boiling point. The return pipe may frost, but frost is no indication that liquid is present, for in our experiment with the glass (see *Power*, July 22, p. 142) we have seen that the gas is capable of taking up a little heat at low temperature and frost will appear a very little way above the liquid. In a small suction pipe a lot of cold gas may frost the pipe before it gets above 32 deg. So do not look at the pipe; look at the thermometer, which should always be in a suction pipe near the compressor.

If the thermometer indicates a temperature of, say, 5 or 8 deg. above the boiling point in the evaporator, one can be sure no liquid is projected. If the compressor is double-acting, also watch the thermometer, and inject on the compressor side only enough liquid to keep the stuffing-boxes in good order. Having done this watch the compressor and see that unnecessary power is not used to move the suction and discharge valves and that gas once compressed does not slip back, to be compressed again.

A picture of what is going on in the compressor can be had by an indicator. The use of the latter instrument has been ably described by others, also the inferences that may be drawn from the "pictures" produced by it. [For an excellent series on indicating the ammonia compressor, see *Power*, April to September, 1916.]

The gas in the suction of the compressor is really produced from a liquid by heat taken up in the refrigerator, and this gas is driven to the inlet of the compressor with some pressure as compared to no pressure. The compressor is only a machine for adding heat in the shape of power, to build up the pressure so that one can use it on dropping down just as one boosts water up into a reservoir for convenience—so one can use it when it flows down.

This use is either in the form of refrigeration direct or in making storage batteries; that is, ice which can be subdivided in large or small lots.

Priorities Between Inventors

BY CHESLA C. SHERLOCK

THE rapid development of many phases of our industrial life, particularly in regard to its relation to the resumption of commerce by the nations of the world, has given a new interest to the patent laws and their application to specific cases.

The question of priorities between inventors has always been one of more or less interest, but it is especially valuable to be well informed upon the subject at this time. With the commercial and industrial interests everywhere "upon their toes," as the expression goes, competition will be no less acute in the matter of obtaining patents than in the matter of capturing markets.

It is a fundamental proposition that he who first reduces an invention to practice is *prima facie* entitled to be deemed the inventor thereof. This does not necessarily mean that he must have originally conceived the root idea or to have worked out everything pertaining to his invention. The courts, particularly the United States Supreme Court, have repeatedly said that they will sustain the patents of those who turn failures and unsuccessful experiments into success. This does not, in turn, mean that one who has conceived the original idea can be robbed of his just reward by a skillful mechanic or engineer who, by reason of his learning and skill, can quickly change a few details and snatch success from the jaws of defeat. It is likewise a well-recognized principle that the person who conceives the original idea is entitled to be considered the inventor of the invention, provided he uses reasonable diligence to adapt it to practice.

The matter of what is "reasonable diligence" has a great deal to do with determining the question of priorities between rival inventors. The prior right always rests with the actual inventor, but he may by his conduct deprive himself of this right even though he did in fact produce and perfect the invention. The courts have said that the inventor may tarry a while in order to experiment with his invention before making an application for a patent, but he is allowed only a reasonable time in which to experiment. If he delays beyond that "reasonable time," he loses his right to priority. The question of what is a reasonable time must, of course, depend upon the circumstances surrounding each case.

It has also been held quite generally that if the actual inventor purposely conceals his invention from the public and takes no steps to assert his rights under the patent laws, he cannot, if in the interval another brings out the invention and patents it. step in and attempt to restrict the latter from enjoying such patent. And it is the settled rule both in the United States and in England that he who first applies for and obtains a patent will be protected by the courts and his rights given priority over another claiming to be in fact the true inventor. This rule may be subject to some modifications, as in case of fraud, but it is so overwhelmingly general as to be settled. Delay on the part of the true inventor in making application is also attended with a great deal of risk, and if losses occur, they too often fall upon the inventor himself. He, of course, has common-law rights, but they are generally extinguished upon the granting of a patent.

Dispatch and diligence in applying for a patent can not be too strongly urged upon all who have invented designs, appliances or machines. Only by the utmost diligence and speed can the true inventor acquit himself of the imputations that always follow a delay.

THE RELATIONS OF EMPLOYERS AND EMPLOYEES

As between employers and employees many questions, not only of interest but of value, arise where patent rights are concerned. Contrary to the general opinion the mere contract of employment does not give the employer the right to all inventions made by the employee. This is true even in cases where the work is done on the employer's time, where the aid of other employees is used, and where the employer's own materials are used to complete the invention.

The point to be kept in mind is that law seeks to secure to the *inventor* all the rights and privileges conferred by the patent laws and not to secure them to one who may morally be entitled to them. An ordinary contract of employment, then, will not give the employer a prior right to the invention, even though he is entirely responsible for the successful completion of it. However, where the employer himself is the originator of the idea and of the scheme for the invention, but hires someone else to do the work necessary to perfect it, a different situation arises. In this case the employer is deemed to be the rightful inventor and consequently is entitled to the prior right to the invention.

In like measure, if the employee is the originator of the idea or scheme that makes the invention possible, the employer cannot come in and appropriate it and take out a patent. The employee is the inventor, and he has a prior right to the invention and to the patent.

Some very interesting cases have been decided upon the rights of employers and employees to patents, but they are interesting in the present discussion only in so far as they apply to the question of who has the prior right. Strictly speaking, unless the employer and the employee are equally inventors or originators of the plan, both cannot be considered as inventors. The real inventor of the two has the prior right in ordinary cases.

These considerations should not be confused with cases where a workman has entered into a contract to *assign* his patent rights upon such inventions as he may successfully complete. They revolve around entirely different conditions.

FOREIGN PATENTS NOT ALWAYS DESIRABLE

There is a particular interest at this time in foreign patents, and this interest will no doubt be greatly intensified in the next few years.

Generally speaking, a foreign patent may not be of any value to an American inventor unless he is prepared to quickly follow it up with active foreign trade. If he intends to market his invention entirely in the United States, he would in most instances be better off to confine his patent activities to this country, because the mere holding of a foreign patent may greatly restrict his rights under our own patent laws.

The Act of July 8, 1879, provided that a United States patent for an invention "previously patented in a foreign country" would expire when the foreign patent did. It further provided that if there were more than one foreign patent the American patent would expire when the shortest one did, and in no case to run for more than 17 years.

What does this art mean to a citizen of this country? In one instance, it means that if an American applies for a patent from the United States Government, then applies for a foreign patent and the foreign patent is granted before the American patent, his American patent will be limited by the foreign patent.

If his foreign patent is for a term of years less than that granted on domestic patents, he will lose just that much by taking out his foreign patent. The question of advisability in taking out a foreign patent hinges, then, upon a determination of which will be the most profitable to the inventor—protection abroad, or domestic profits for the full term guaranteed under the United States patent laws. Of course, where the inventor is prepared to market his invention in the foreign country where he seeks patents, a different matter arises.

It is not necessary, according to the courts, for the United States patent to be expressly limited on its face to the term of years for which the foreign patent limiting it is to run. The courts have also held, in relation to this matter, that "a patent for an invention does not expire at the same time with a foreign patent for the same invention unless the foreign patent was obtained by the American patentee or with his consent."

The Act of Mar. 3, 1897, which amended in some particulars the earlier act, was such as not to affect the life of a domestic patent granted on an application filed on or after Jan. 1, 1898, to the life of a prior foreign patent, provided that the application for the domestic patent was filed within seven months from the filing of the foreign patent.

How a Large Power Plant Was Kept in Service

By L. W. WYSS

In a large hydro-electric station there were two three-phase transformers which stepped the generator-bus voltage of 5000 down to 210 and 122 volts for station power and lighting. A burn-out in one transformer did not cause any inconvenience, as it was quickly disconnected from service and the remaining transformer had ample capacity to handle the station power and lighting load. However, before new coils could be secured for the burnt-out transformer, the other one failed. The burn-out of each was so severe that repairs were impossible without obtaining coils from the manufacturers.

Conditions were now very serious, as no source of power was available to drive the motor-driven station auxiliaries. The most important auxiliaries were the high-tension transformer circulating-water pumps and the governor oil-pressure pumps. Since the high-tension transformers were loaded to very near their capacity, it would perhaps be only about an hour before they would overheat and the greater part of the load would have to be dropped. The hydraulic governors were useless without the oil-pressure pumps in operation, therefore the only thing to do was to connect the handwheel control to the turbine gate shafts, which was done at once. With handwheel control the speed and voltage regulation was poor under normal load conditions, but was better than a shutdown. In the event of a storm causing short-circuits on the transmission lines and resultant sudden loss of load, this method of operating was extremely hazardous because it was impossible for the operators to close the gates fast enough to prevent dangerous racing of the large hydro-electric units.

The station chief was present at the time, and he immediately helped the turbine operators and wipers to put the machines on handwheel control. Men were stationed at four of the six turbines which were running at this time.

During the time the change over was being made, the switchboard operator had called the two reserve steam stations, which were combined with the substations in two cities at the receiving end of the two 120,000-volt transmission lines. The boilers were fired at once at these stations, but it is doubtful if they could have relieved the hydro-electric plant of the load before the transformers would have heated to their limit. The switchboard operator then called the other available station operators who were off shift, thinking that they would be of assistance.

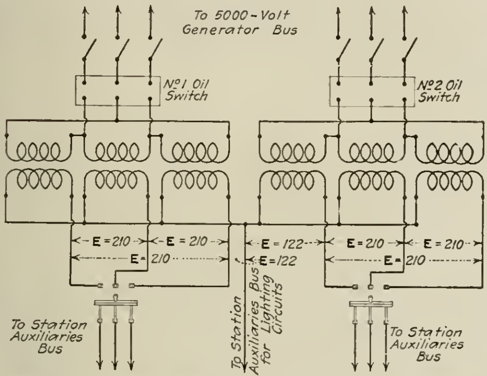

To 5000-Volt Generator Bus
No 1 Oil Switch
No 2 Oil Switch
E=210
E=210
E=210
E=122
E=122
E=210
E=210
E=210
To Station Auxiliaries Bus
To Station Auxiliaries Bus for Lighting Circuits
To Station Auxiliaries Bus

FIG. 1. SHOWS HOW THREE-PHASE TRANSFORMERS WERE CONNECTED

The big problem was how to provide cooling water for the transformers. Gravity feed from the forebay was impossible as the transformers were higher than the head-water elevation. It was realized that some scheme must be devised to drive one of the triplex circulating pumps. These pumps were belt-driven and in duplicate, either being capable of pumping enough water for cooling purposes. They were located behind two of the generators, and it would take considerable time to set up any temporary drive that would connect a pump to a generator shaft. The chief was still studying this problem when one of the operators that was off shift arrived in his automobile. After a brief discussion the latter remarked that he thought his car could drive the pump if there was any way to get it in position, which would be difficult, because there was not room to take it in between the generators. The traveling crane solved this part of the problem. The car was driven into the plant as far as possible, then using the crane it was lifted high enough to clear the generators and set down near one of the pumps. One rear wheel was blocked while the other was lined with the pulley of the pump and the tire taken off. After splicing the two pump belts to make one long enough to reach, the car was ready to drive the pump. While it did not work very smoothly, it was good enough to rely on for a short time.

While this work was being done the chief thought of a plan to obtain power for the station auxiliaries. The station transformers that were burnt out were connected as shown in Fig. 1, 210 volts being available for motors and 122 volts for lights, the latter being taken from one phase and neutral.

The station contained three banks of single-phase transformers and a spare, the former stepped the voltage from 5000 up to 120,000 and were connected delta, to delta. A little figuring showed that the ratio was 1 to 24, and dividing 5000 by 24 indicated that by connecting 5000 volts to the high-tension terminals the resultant voltage at the low-tension terminals would be about 208, which would be satisfactory for the station auxiliaries.

If an entire bank of these power transformers were used for this purpose, there would not have been sufficient capacity in the other two to handle the load for any great length of time. It was then decided to take one bank out of service long enough to disconnect the low- and high-tension terminals of one transformer. This left the two other units connected in open delta, and when again placed in service they were capable of handling only 57.7 per cent. of the load which three units could handle. This, however, was sufficient to handle the load that this bank of transformers supplied. Some insulated cables were then used to connect the transformer taken from the bank and the spare unit in open delta, as shown in Fig. 2. Power was now available to drive the transformer cooling-water pumps and governor pumps. For the 122-volt lighting in the station some temporary wiring was done to connect the lighting circuits of the station to the 125-volt exciter bus.

By referring to the switchboard operator's records, it was found that the burn-out happened at 11:14 a.m., the automobile was driving the transformer cooling-water pump at 12:25 p.m., a steam turbine was on the line at one of the steam plants at 12:57 p.m. to take care of the load variation, and at 2:20 p.m. the temporary transformer connections had been made and the hydraulic governors were again in service. There were no service interruptions whatever. During the time that the high-tension bank of transformers were out of service, a tie switch was closed, which allowed the other two banks to handle this load.

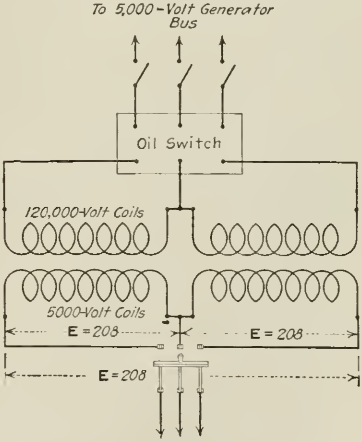


FIG. 2. TWO TRANSFORMERS CONNECTED OPEN DELTA

Failure of Diesel-Driven Alternators to Parallel

By D. L. FAGNAN

After giving fine service for almost a year, an electric-light plant containing two 16 x 24-in. Diesel engines driving alternators suddenly developed trouble through irregular running and thumping of one of the engines, causing the alternators to fail to parallel. The engines were of the three-cylinder vertical type, ran at a speed of 164 r.p.m. and developed 225 hp. each.

Normally, only one engine was used, but as the load came on, the other was put into service. The faulty operation that resulted was an annoyance because the plant had no reserve capacity and both engines were needed to carry the peak loads. As a consequence part of the load had to be dropped until the trouble was remedied, which was a serious matter in an electric-light plant.

There was no particular trouble under light loads, except that the middle cylinder of one of the engines had a muffled thump. This was detected by touching the cylinder with a lead pencil gripped firmly in the teeth, the ears being held shut to keep out other sounds. To determine the cause of the thump, the indicator was brought into play, and then it was discovered that this cylinder was doing no work, the oil being ejected into the exhaust pipe without being burned.

On shutting down the engine and taking out the exhaust valve, inspection showed distinctly that the piston head was wet with oil and that considerable carbon had formed on it. This carbon had caused thumping by striking the cylinder head at the end of the stroke. The indicator had shown a very low compression, so we dismantled the top gear, cylinder head, piston and connecting-rod and brought the piston down to the floor for better observation and repairs.

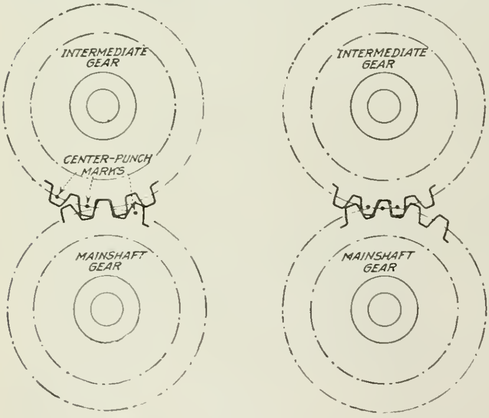


FIG. 1. SHOWING MISADJUSTMENT OF TIMING GEARS

We found the upper two piston rings gummed solid in their grooves and broken in a number of pieces. The next four rings were carbonized badly, and only the lower wiping oil ring was in good condition. The cylinder walls were very gummy and dry, and all four openings for lubricants were filled with solid carbon and glazed over. There were some chewed-up spots near the upper part of the liner, caused no doubt by the sharp edges of the broken piston rings.

While assistants cleaned the piston and put shims under the piston-pin bearings, I fitted the new rings to the cylinder and passed them down to the men, who fitted them to the piston grooves by filing and scraping thoroughly. Next, we scraped, filed and smoothed up the cylinder liner where it was rough, cleared the oil ways, and made sure, by testing each passageway, that the lubricant would reach the piston. All inlet and exhaust valves were ground in, after which all parts were re-assembled. While these jobs were being done, the engine was keyed up all around and given a thorough inspection.

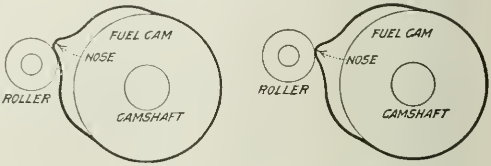


FIG. 2. INCORRECT AND CORRECT CAM SETTINGS

When we started off, I noticed a slight wabbling of the flywheel, and on asking how long it had run that way I was told it had always done so. As all the bearings were in fine shape, none being low or worn to speak of, I ordered the engine stopped. Using a steel scale as a straight-edge on the planed surface of the hub, I found, as I had suspected, that the hub had not been placed absolutely true on the shaft. It was the work of only about an hour to loosen up the hub bolts, and, using an improvised ram made of a piece of 3-in. shafting swung from a rope, to true up the hub. After retightening the bolts and starting up, the wheel ran absolutely true. It is well to remember that a slight inequality in trueness of the hub will cause a wabbly wheel, which is an eyesore to a good mechanic.

The oil pump and the governor had been examined thoroughly, but on checking up the setting of the fuel cams and noses, something seemed amiss. The engine was barred over slowly, and when the valve timing was checked there was no further wonder why the engine had rebelled. The intermediate and main gears were out of adjustment by two teeth, as shown at the left in Fig. 1. This setting was corrected, as shown at the right in the same figure.

We next turned our attention to the fuel-cam noses. Fig. 2 shows at the left the setting as we found it before the intermediate gear was correctly adjusted, and at the right is shown the corrected setting. The engine was then started up and after putting on a full load it ran normally. The engineer declared that it ran better than he ever saw it do before. However, he had been on the job only about two months, as he had come from another Diesel plant in the East.

The indicator was applied to the engine and the diagrams showed normal action. So we switched the load back to the other engine and again put the repaired engine in parallel to make sure that everything was all right before leaving. We waited for the peak load to come on, for we had sent out word to switch on the loads everywhere as the engines were all right again. The load came with a rush, but the engines stood up to it in fine style. As soon as the load dropped that night and one engine could carry it alone, we switched off all load from the repaired engine and applied the indicator. The compression pressures in all three cylinders were observed for future reference and were 480, 503 and 470 lb. per sq.in. in cylinders Nos. 1, 2 and 3, respectively. As No. 2 cylinder was the one that had been overhauled, the figures showed that the pistons of Nos. 1 and 3 should soon be fitted with new rings or else shims should be put in under the piston-pin brasses to increase the compression. This shimming can easily be done by the engineer. The piston can be jacked up and the shims inserted in the opening thus produced under the brasses.

Separation of Costs in a Combined Steam-Heating and Electric Plant

By H. W. MEYER

This article describes a method for separating the coal costs chargeable to the electric from that of the steam-heating department. All other boiler-room costs are divided between these departments in the same proportion as the coal costs.

WHEN exhaust steam from reciprocating engines or steam turbines driving electric generators is used for steam heating—both electric and steam-heating services being supplied to the public—it becomes necessary to separate the operating costs chargeable to each utility. This is necessary in order that equitable rates may be fixed for both classes of service and that the proper return may be earned on the investment for each. Such a separation of operating costs must be made on a basis that will bear scrutiny by rate commissions, by investigating committees or by the consumers themselves.

Other operating costs than those relating to the boiler room are either by their nature chargeable directly to one or to the other utility or they must be separated by some other means. For example, the maintenance of steam-distribution mains is purely a steam-heating charge, while general expense, including the salaries of general officers, office supplies and the like, applies to both the electric and the steam-heating departments. The separation of such costs as these might well be made in proportion to gross earnings.

Combination electric and steam-heating plants may operate under many conditions, and any method that may be used in the separation of costs must be sufficiently general in its application to cover them all. We may have a steam-heating load in excess of the supply of exhaust steam available, in which case live steam must be introduced into the mains in addition to the exhaust. If the reverse is true, the company should either secure additional steam-heating business or install condensers for some of its prime movers. In some cases both high- and low-pressure steam must be supplied, the former being used for cooking, laundry work and the like. The generating apparatus may be interconnected with other and more efficient steam-generating stations and with water powers. The generating apparatus may consist of reciprocating engine-driven or turbine-driven generators or both.

In arriving at the amount of coal chargeable to the electric department, we are justified in assuming that as much coal should be charged to this department as would be charged if similar generating units, operating under similar load conditions, exhausted into condensers.

It is assumed that the station contains a number of generating units and that only so many of these will be operated at any time as will permit each to carry approximately its most economical load. Under these conditions the steam consumption of each unit will be proportional to the kilowatt-hours generated by that unit. The number of tons of coal consumed for the generation of electricity will not be in proportion to the kilowatt-hours generated, but will depend on the output and the maximum load which the station must be in readiness to carry. We may say, therefore, that the total tons of coal consumed during an interval of time will be equal to a constant times the kilowatt-hours generated plus another constant times the maximum load that the station must be prepared to carry during such interval of time.

It must be remembered, in what follows, that all calculations are based on the performance of condensing generating units of the same capacities and kinds as those installed in the plant in question.

Since public utilities ordinarily make monthly operating reports, the logical unit of time in these calculations would be the month. Based on the foregoing statements, we may write the following equation:

$$\text{Pounds of coal consumed per month} = K_1\,(\text{kw.-hr.}) + K_2\,(\text{kw.})$$

K_1 is equal to the pounds of coal per kilowatt-hour found by dividing the kilowatt-hours generated into the pounds of coal required when operating condensing after deducting an amount of coal equal to that which would be required to maintain a hot banked fire under the boilers required for generating electricity.

K_2 is equal to the pounds of coal per month required per kilowatt of maximum demand for which the station must be in readiness during such month, to maintain a hot banked fire under the boilers required for generating electricity; that is, fire just sufficient to maintain steam pressure without delivering steam.

K_1 may be found by the use of Fig. 1. For example, if the actual evaporation is found to be 6.5 lb. of steam per pound of coal and the banking fuel per developed boiler horsepower is 200 lb. per month, we follow the oblique line corresponding to 6.5 lb. to the intersection with the horizontal line corresponding to 200 lb. and follow the vertical line through this intersection to its intersection with the curve corresponding to the steam rate (condensing) of the prime mover. The length of the ordinate at this point is K_1. If in this example we take the steam rate to be 17 lb. per kw.-hr., K_1 is 2.45 lb. of coal per kw.-hr.

K_2 may be determined from Fig. 2. Using the pounds of fuel required per boiler horsepower (developed, not rated boiler horsepower) for maintaining a live bank, as an abscissa, find the intersection of the corresponding ordinate with the line corresponding to the rated steam consumption (condensing) of the prime mover. The length of the ordinate at this place will be the value of K_2.

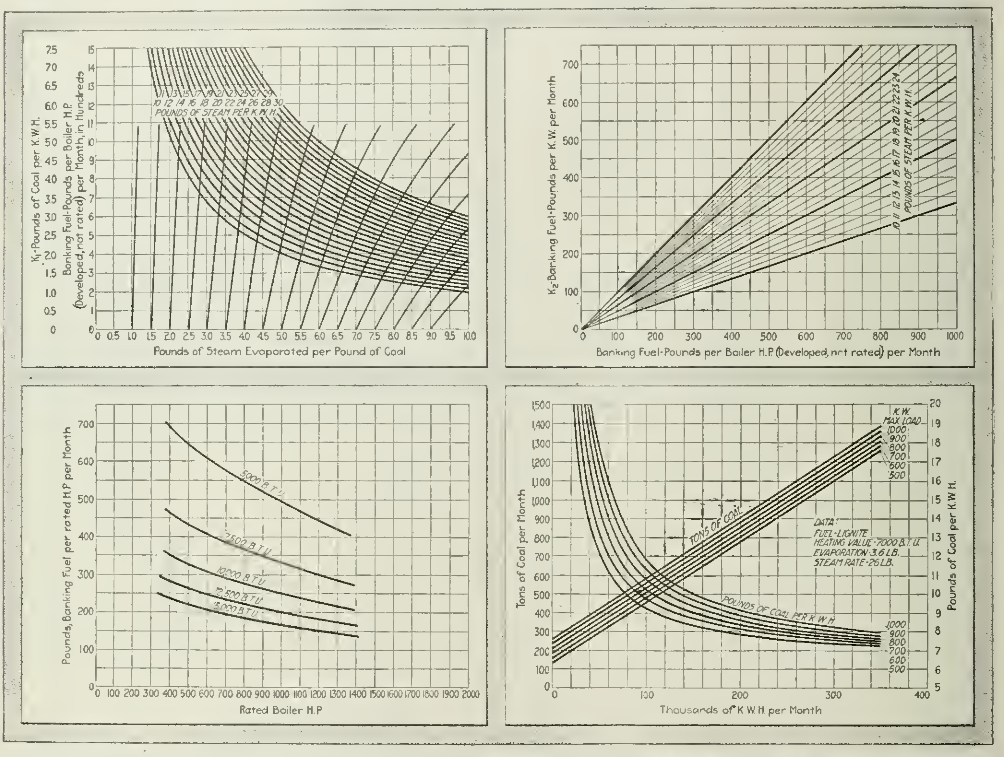
Fig. 3 may be used as an aid in determining the fuel used. The length of the ordinate at this place will be the pounds of banking fuel per rated horsepower per month (30 days). If the boiler is operated at 200 per cent rating, only one-half the amount found should be applied to Figs. 1 and 2.

Having determined the values of K_1 and K_2, they may be substituted in the equation,

Pounds of coal per month $= K_1$ *(kw.-hr.)* $\div K$ *(kw.)*

It will be found convenient to make up curves similar to Fig. 4 by the use of this equation.

When there is a wide difference in the steam rate of various units in a plant, it may be necessary to treat each unit separately.



FIGS. 1 TO 4. CHARTS SHOWING THE SEPARATION OF COSTS IN A COMBINED STEAM-HEATING AND ELECTRIC PLANT

Fig. 1 (upper left)—To find the number of pounds of coal per kilowatt-hour. Fig. 2 (upper right)—For finding the number of pounds of banking fuel per kilowatt-hour per month. Fig. 3 (lower left)—To find the number of pounds of banking fuel per rated horsepower per month. Fig. 4 (lower right)—For finding the number of pounds of coal used per month.

required for banking when this is not definitely known and is based on data from actual operation. Fig. 3 refers only to rated boiler horsepower. Since boilers are often operated at 200 or 300 per cent. of their rating, over the peak, before applying to Fig. 2, these figures would be reduced proportionately.

Fig. 3, of course, cannot be taken as accurate under all conditions, but is intended merely as a guide which may be of assistance in determining this factor where it is difficult to find it directly. In using it find the abscissa which corresponds to the horsepower rating of the individual boilers in question and then find the intersection of the corresponding ordinate with the curve corresponding to the heating value of the fuel used.

The following form is suggested as a means of keeping a record of these data:

Name of Company Plant. . . . . . .

Month . . . . . 19. .

Determination of Fuel Chargeable to the Generation of Electricity

Unit No.	Capacity, Kw.	Kw.-Hr. Generated	K_1	K_2	Pounds of Coal = K_1 (kw.-hr.) ÷ K_2 (kw.)
1					
2					
3					
Totals,					

Calculated by. . . . .

EDITORIALS

To Earn More Learn More

SOME forty years ago a number of power-plant engineers got into the habit of meeting in the engine room of the court house at Providence, R. I., and talking over the problems of steam engineering. At first irregular and informal, these gatherings developed into an organization which, uniting with and inspiring similar organizations in other cities, led to the founding of the National Association of Stationary Engineers, an organization unique in character, evolved naturally out of the environment in which the craft found itself.

The steam engine, the mainspring of the factory system, the muscle of industry, had come into its own. The steam plant, simple as it then was compared with the plant of today, had an interesting technology, offered opportunities for all sorts of savings through the exercise of invention, intelligent supervision, and ingenious application. The indicator was becoming known to the operating engineer, valve setting was becoming less of a shop mystery, there were different methods of firing to discuss, and various methods for making the operation of the steam plant more dependable and economical to be devised and considered.

One may realize the possibilities of those times by looking over the advertising pages of the current issue of *Power* and noticing how many of the devices there presented have been produced and have made fortunes for their inventors and promoters in the intervening years.

The men in charge of those plants were not technically trained men, that is from the technical-school point of view. Even the technical schools had looked askance upon the engine at first as a subject of scientific teaching and it was only at about the time of the inception of this association that steam laboratories began to be considered as legitimate features of the equipment of such institutions.

These practical men, drawn together by a common interest in their vocation, obliged to work out its theory and principles, to learn its traditions and fundamentals by their own effort and from sources which they must aid each other in seeking out, perfected an organization based upon mutual helpfulness in learning, which has endured for thirty-seven years and the delegates to whose annual convention at Huntington, W. Va., this week represent some twenty thousand members scattered all over the country. They looked for progress and uplift for the individual and for the craft through education. Their motto is "To Earn More Learn More." They considered themselves as in rather the executive than the operative class, as heads of departments rather than as "hands," and expected to better their condition rather by improving their capacity for service and their capability for assuming responsibility than by the exercise of the collective demand.

This is a spirit which should have been welcomed and cultivated by every owner or manager of a steam plant. It can safely be said that without the opportunities for study and training afforded by this and similar organizations which have sprung up it would have been much more difficult to provide that combination of practical and theoretical man that is necessary to the most successful operation of the complicated modern plant. Many of the members of the association have won recognition and fill positions of responsibility and emolument, but the recognition has been far from universal.

It is probably natural that employers should have responded more readily to organized demand than to modest nonassertiveness, awaiting spontaneous recognition of its increased worth. But it is regrettable that employers should have allowed a situation to develop where the organized mechanic or mason can boast to the chief engineer who employs him that he works fewer hours for higher wages than the engineer does. A cordial recognition of the engineer in the spirit of this organization might even now be a wise precautionary measure as well as an act of justice to a more than ordinarily deserving and a less than ordinarily appreciated class.

Refinements in Steam Turbine Design

THE growth of the steam electric power industry has reached the stage where the users are evidencing keen interest in the practices and problems of the designers. This is an important step in the progress of the art in that it will bring about a closer engineering analysis of designs submitted by manufacturers, and will be an important factor in stimulating development along lines in which proper relative consideration will be given to reliability, efficiency and cost.

In this connection, the article entitled "Refinements in Steam Turbine Design" by Prof. A. G. Christie, will be read with much satisfaction, particularly by users of steam turbines.

The problems referred to in this article have been familiar to designers for years, and much has been done toward their solution. The early success of the turbines introduced by the Honorable Charles A. Parsons was largely due to the progress he made in the solution of the problems of detail design. Further slight gains along these lines are still possible and closer attention will be centered on them as sizes and general designs become further standardized so as to require less attention on the part of designers, and as costs of fuel, with corresponding demand for greater refinement in efficiency increases.

That the ultimate turbine will employ high blade speeds and high stresses is debatable. Higher efficiency and greater durability of the blade or bucket elements are to be obtained by keeping the velocities as low as practicable. Polished surfaces cannot be maintained, especially in machines which are not in continuous operation and therefore subject to corrosion, nor in machines which employ extremely high speeds where erosion is active. With low speeds, both erosion and friction losses, which polish tends to reduce, are minimized.

While the highest obtainable efficiency of a machine when new is of some importance to users, the actual average operating efficiency over a term of years comprising the useful life of the machine is of considerably greater importance.

All turbine elements are designed along lines believed to be theoretically correct. Increasing experience affords more accurate knowledge of the relative importance of the various factors involved and thereby leads to further improvement.

Rising costs of fuel and labor and the resistance against corresponding increase in power rates are factors which are forcing both the designer and user to exert every possible effort toward obtaining the highest possible efficiency in design, manufacture, and operation of our present-day electric power apparatus.

Increasing Application of Alternating-Current Machinery

THE tendency in the application of electricity to light and power purposes is toward a greater use of alternating current. There is one field, however, where direct-current must be used; namely, in electrolytic work, and, at the present stage of development, is also preferable in electric welding. Where adjustable speed motors are required for wide ranges of speed the alternating-current machine has not as yet reached a development so as to successfully meet these requirements. However, when the need for such an alternating-current motor becomes sufficiently urgent there is little doubt that such a machine will be forthcoming. In fact such machines have already been developed but have not up to the present become a serious competitor of the direct-current machine. Outside of these applications alternating-current equipment compares favorably with direct-current machinery and in some cases is superior.

There seems to be a tendency on the part of practical electrical men to look upon alternating-current equipment as something mysterious. Not infrequently the statement is made "I understand direct current but alternating current, that is so complicated I never could understand it," when the chief reason for the lack of understanding is absence of study of the subject. If one has become familiar with direct-current machines through five or ten years' association with and study of this equipment, it is not reasonable to expect to have the same understanding of alternating-current equipment by only a casual consideration of the subject, and this with the idea fixed in the mind that the subject is very complicated. The true facts of the matter are, one is no more complicated than the other, in fact most alternating-current motors are more simple than direct-current machines, and the alternating-current motor of the induction type operates on the same principle as the direct-current machine, the only difference being in how the current is obtained in the rotating element's conductors. To assist in clearing away some of the mystery with which some of our readers have shrouded the operation of an induction motor, there is published on page 382 of this issue an article "The Rotating Magnetic Field of Alternating-Current Motors" which shows that the revolving magnetic field is produced in practically the same way as taking two permanent bar magnets and arranging them in consecutive positions on a plane so that they move across the surface in steps equal to the width of one magnet. A conscientious study of the explanation given in this article should prove a basis of a more intimate acquaintance with the principle of alternating-current motors.

The Biggest Move Since the Preamble Was Written

THE National Association of Stationary Engineers is the largest and perhaps the only body of its kind in the world. For the nearly twoscore years of its existence it has held apart from labor interference, spurned numerous attempts to convert it to a labor union, yet without suggesting that individually its members should not affiliate with such organizations.

According to its preamble it is avowedly an educational institution. It seeks to better the working and living conditions of its members through higher knowledge and greater skill in power-plant operation. However, the engineers of late have taken comparatively little interest in educational programs. Take, for example, the number of members entering the contest for the prizes offered by the National Educational Committee of the National Association of Stationary Engineers. It is most disappointingly low. And, be it understood, not because the committee's plan was not good—it was exceptionally meritorious. But the men were not interested. It is one thing to be interested, but another to be sufficiently interested to be stimulated to do that in which you are interested. There is not one in all the more than twenty thousand of this association who have been charged with the responsibility of the national or subordinate association educational work who does not know how exceedingly difficult it is to keep the men actively engaged in the educational affairs.

There are two causes: One, that many of the men, like so many others in this field, have lost heart, because of the meager reward for the effort; the other, that members, growing old and naturally less interested than youthful ones, dominate affairs—business, educational and social. There is not enough young blood.

The appointment of a technical papers committee at a recent convention and the setting apart of time for welfare discussion by the delegates to the national convention was a great forward step. It marked the beginning of a new era for the association. This year, at the coming convention, will be taken a step which in fruitful possibilities will be greater still, will in fact be the biggest step taken since the adoption of the preamble. The resolution aims to permit the association to take in as members engineers who are eighteen years of age, instead of holding up the limit to twenty-one as at present. Some states permit a man of eighteen to hold a license. The fact is that today men are reaching a given stage in industry and human affairs at an earlier age than was common years ago. Here is the source of that fertile young blood so much needed.

And now the International Union of Steam and Operating Engineers, affiliated with the American Federation of Labor, is formulating a plan to strike for eight dollars for an eight-hour day and double pay for overtime. The engineers of a single industry are not numerous and could be easily replaced, but it would be difficult to conceive of anything which would tie a community up more than shutting down its steam plants.

· Correspondence ·

Surface Condensing Plant Temperatures

In *Power* for July 15, page 92, there is a short article entitled "Surface Condensing Plant Temperatures," which gives information that appears erroneous and misleading. Good surface condenser practice at present does not require 10 deg. F. difference between hotwell temperature and theoretical vacuum temperature and it does not require 15 deg. F. to 30 deg. F. between hotwell temperature and cooling-water discharge temperature. Fortunately, in the preceding article describing a recent condenser installation you have provided me with data necessary to prove my point. From data available I have made the following tabulation:

	Recommended Practice in Article in Question, Deg. F.	Worthington Condenser Guarantee, Deg. F.
Circulating water, inlet	70	70
Rise in temperature of circulating water, assuming 920 B.t.u. per lb. steam and 78 to 1 water-steam ratio	12	12
Circulating-water outlet temperature	82	82
Difference circ.-water and hotwell temperature	15 to 30	11.8
Difference hotwell temperature and vacuum temp.	10	
Vacuum temperature	107 to 122	93.8
Vacuum, 30 in. bar, in. mercury	27.6 to 26.4	28.4

Clifton, Ariz. N. G. HARDY

Flue-Gas Analysis and CO_2 Recorders

Mr. Baxter's article on "Flue-gas Analysis and CO_2 Recorders," in the issue of July 22, certainly throws light on a phase of boiler economy that is too often disregarded. If it is desired to obtain a record of the oxygen in the flue gases, and the size of the plant justifies the added expense, it can be done by the use of two recorders, as shown in Fig. 1.

The CO_2 recorder would operate as usual, with a solution of KOH (potassium hydroxide), while the oxygen recorder would operate with pyrogallos and KOH, like the Orsat. The CO_2 would be removed from the gas going to the oxygen machine by a solution of caustic soda in the scrubber tank between the two machines. This tank should hold about three gallons, containing, say, 15 lb. of soda, which would give purification for two or three months, on 24-hour operation, assuming that one-half the gas purified was used in the recorder.

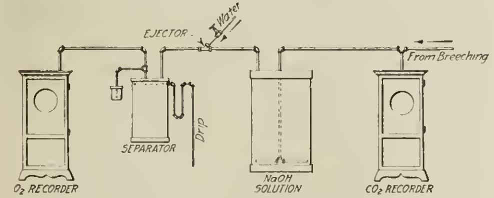


FIG. 1. USING TWO RECORDERS

Owing to the increase in volume of the solution as it changes to carbonate, a small space should be left for expansion.

An ejector made up of small pipefittings and operating on water pressure would draw the gas through the soda solution, the water being taken out in the separating tank, and a small water-sealed vent provided to prevent undue pressure, which might affect the accuracy of the recorder. A small amount of gas discharged through the water seal would do no harm, except to use up the soda, and would materially decrease the time lag of both machines. The actual percentage of oxygen in the gas would be $\frac{100 - CO_2}{100} \times O$ This would give an accurate record of excess air, affected only by the oxygen burned to water due to the hydrocarbons in the coal.

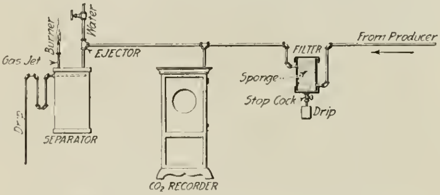


FIG. 2. ILLUSTRATING USE OF FILTER

We have been operating a recorder for the last year on anthracite producer gas and find it essential to accurate operation that the gas be thoroughly clean. By means of the connection shown in Fig. 2 we not only clean the gas, but materially decrease the lag of the recorder. The water valve is regulated to keep a $\frac{3}{4}$-in. burner going nicely; this arrangement gives a lag of less than 5 min., about the interval between successive records.

We are obtaining gas averaging less than 5 per cent. CO_2 for a 24-hour run, on continuous operation, and have, under favorable conditions, obtained gas showing less than 3 per cent. for an entire 24-hour period. This was with a new fire, in a 7-ft. producer, making approximately 15,000 cub. ft. of gas per hour. Can you beat it? A. H. BULLARD.

Syracuse, N. Y.

Pressure on Crankpin and Guide

The solution of pressure on crankpin and guide, page 29 of the July 1 issue, appears to be in error. Where *CB* is the length of connecting rod and *CA* is the distance from center of crosshead pin to center of shaft, or horizontal distance from the crosshead pin to center of crankpin, when the crank is at right angles to the direction of stroke, then the thrust on the connecting-rod would be $CB \div CA \times$ pressure on the piston, or $5 \div 4.899 \times 9000 = 9185$ lb., in place of 8818.2 lb., and the pressure on the guide would be $\frac{1}{4.899} \times 9000 =$ 1837 lb., in place of 1763.6 lb. A. VENNING.

Brooklyn, N. Y.

[The correspondent is right and the solution given is in error, as he has pointed out.—Editor.]

Why Not Express Vacuum Values in per Cent?

After having traveled from Denver, Colo., to New Haven, Conn., it would seem to me that it would be so much more satisfactory if vacuum values were stated in per cent. instead of in inches by engineers. It is lamentable to find so many engineers and chief executives under the impression that they should be getting 28 in. of vacuum at altitudes of 1000 to 1500 ft. above sea level.

Some years ago, while operating a plant that was located about 1200 ft. above sea level, I turned my hair gray trying to maintain 27 in. of vacuum in everyday practice on a low-level jet condenser with water coming from a cooling pond. After I had studied night and day and tried everything I could think of, as well as the various suggestions and recommendations of several condenser experts from the manufacturers, I was still in the dark.

About this time I made a trip east to a convention, and while there I secured all the data I could on vacuum, condensers and cooling ponds. This experience caused me to think of the idea of expressing the vacuum in per cent., since the barometer was different in almost every case. Furthermore, I observed that the actual barometer varies considerably below that which corresponds to the local altitude, as the relative humidity has a greater effect than most persons realize.

VACUUM EXPRESSED IN PER CENT.

Average Values in Everyday Operation

Locality	Weather	Barometer, Inches Hg.	Vacuum Inches, Hg.	Vacuum Per Cent.
New Haven, Conn.	Fair	30	28	93.4
	Stormy	29.6	27.6	93.5
		Maximum	Maximum	
Dayton, Ohio	Clear	30.4	29.4	96.5
	Fair	29.3	27.4	93.5
	Stormy	28.9	27.4	95
		Maximum	Maximum	
Akron, Ohio	Clear	29.7	28.6	96.5
	Fair	29.1	27.2	93.5
	Stormy	28.7	26.8	93.5
		Maximum	Maximum	
Kansas City, Mo.	Clear	29.4	27.4	93.0
	Fair	28.7	26.8	93.5
	Stormy	28.3	26.4	93.5
	Clear	29.1	27.2	93.5

Note—Lowest barometer occurs before a thunderstorm or during a snowstorm.

At the present time the vacuum in inches means nothing to me until I know the actual barometer; then I divide the vacuum by the barometer in inches, which gives the value in per cent.

As a 28-in. vacuum with a 30-in. barometer at sea level on the Atlantic coast is considered a good everyday average, I use this as a basis for comparison. Dividing 28 by 30 we get 93.33, or nearly 93.5 per cent. vacuum.

Perhaps some engineers will say this is too low, that they maintain 28.7 in. vacuum or 95.6 per cent. every day. So have I. However, I have never been able to observe any decrease in the readings of the steam-flow meters (including auxiliaries) after increasing the vacuum to this value. I have found this to be true on all three of the leading makes of turbines up to 10,000 kw. capacity. I think this is easily accounted for, as a turbine designer has just recently admitted that very few turbines are able to secure the full benefit of this increased vacuum because the last row of blading cannot be commercially built to handle this enormous volume of steam.

In this connection I might mention that I have observed three instances in which the flow meters did not show an increased flow when the vacuum was dropped 3, 5 and 7 per cent. respectively (steam flow to turbine only). This was due to leakage in the dummies and boiler smudge in the blading. The flow meters were carefully calibrated and all piping tight.

The accompanying table shows actual conditions as observed by myself with values expressed in per cent.

Franklin, Ohio. WALDO WEAVER.

Danger of Oil in Boilers

A certain tannery uses its five horizontal-return-tubular boilers to operate noncondensing engines and some live steam to supplement the exhaust for heating and drying purposes. All the exhaust steam is condensed in banks of heating coils, the drips returning to an open heater, from which the condensate is fed to the boilers.

The oil separator on the side of the feed-water heater was imperfectly dripped and permitted oil to go to the heater. Although the well-placed oil separators in the exhaust lines near the banks of heating coils were of excellent design, they were improperly dripped. It is well known that the drain from an oil separator should be continuously free and open. No valves are needed in such drains, and their presence is a menace as, if carelessly or ignorantly shut, the separators cease to operate and oil passes into the coils. It is usually necessary to provide a pipe seal for the drain from the oil separator in order to adapt it to the exhaust pressure.

These drains in the tannery were equipped with valves, and one separator had its drain hooked up to a system of pipes discharging at an elevation of about five feet above the separator, these pipes being used for other purposes. This resulted in a checking of the drain from the separator, a defect which had existed for three years.

Boiler-insurance inspections, about a year ago, had called attention to the presence of oil in the boilers. The first warning of injury came with leaks around the girth seam of the shell immediately over the fire. This was followed by the rear tube ends leaking. Calking and reëxpanding stopped the leaks for a time, but they reappeared in aggravated form, until it was evident that the situation was serious if not dangerous. An examination disclosed considerable oil in the boilers, and the defects in the oil-separator drains were found.

Measurements showed that the boiler shells had been bowed-up, or "hogged," the permanent arching being five-eighths of an inch in the shell length of 16 ft. The lower tubes had been pushed through the back tube sheet a distance of one-quarter of an inch, although they were not only expanded but the ends were beaded. The $1\frac{1}{2}$-in. braces joining the heads below the tubes were bowed up about three inches and touched the tubes. The lower tubes were bowed up about an inch.

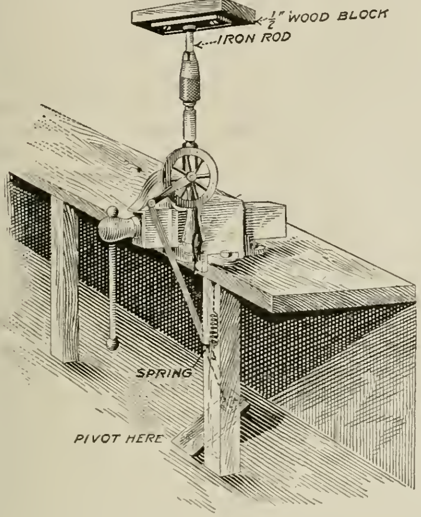
How did the boilers happen to bow upward? If a bar of iron is heated and cooled repeatedly, its length is reduced. The oil on the lower sheets of the boilers was an excellent nonconductor of heat and checked the flow of heat to the water, thus causing the shell to become overheated to some extent. This repeated overheating of the bottom of the shells drew the lower edges of the heads togther by the shortening of the length of the bottom of the shells, the top of the boiler remaining undeformed, the tubes being pushed through the rear head. JAY M. WHITHAM.

Philadelphia, Penn.

Cleaning Boiler-Tube Plates

Cleaning the tube plates of a boiler is a tedious operation. In a certain plant the plates were washed and allowed to dry, and the ground surface was then cleaned by rubbing the plate on a smooth board on which fine crushed ashes were spread.

This work was afterward facilitated by means of the simple device shown in the illustration. A common breast drill was clamped in a vise and a pedal attachment arranged to revolve the handle. A circular piece of smooth board, one-half inch thick, was attached to a piece of quarter-inch iron. This was then clamped in the chuck of the breast drill. As the board revolved ashes were thrown on the board and by pressing the cap against the revolving surface the plate was rapidly cleaned.



DEVICE FOR SURFACING TUBE PLATES

Fine emery cloth may be used instead of ashes.

Richmond, Va. JAMES M. PURCELL.

Boiler Blowdown Indicator

The illustrations depict a device that I have designed, the purpose of which is to show when the boilers have been blown down.

Two bands are secured to the blowoff pipe with two iron rods clamped between, as shown in Fig. 1. Double points on the rod *A* are not necessary, but care must be used to get the contact points so that they will meet when the pipe expands. The bent part of the rods should be thin enough to give if the expansion exceeds that for which the rods are set, usually about $\frac{1}{16}$ in. The contacts are insulated as at *C*. If a watchman's electrically operated time-recording clock is used, wires from the rods are connected to the clock. As connection may be made for some time, it will be necessary to sharpen the edge of the clock punching pin so that it will cut the disk instead of crumpling and tearing it due to the disk movement. The slit in the disk will show the time and duration of the blown-down period.

If no watchman's time clock is available, an outfit such as shown in Fig. 2 can be made. It consists of a piece of 2-in. iron pipe open at the top and capped on the bottom. *B* is a $\frac{1}{2}$-in. globe valve with a threadless valve stem. The rod *D* is connected to the blowoff pipe as shown in Fig. 1 and has movable joints at *C*, *E* and *F*. The rod *D* is moved by expansion of the blowoff pipe in the direction of the arrow. A water-glass *H* is attached to the iron pipe which also contains water.

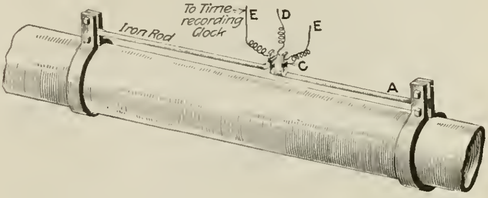


FIG. 1. CONTACTS ON BLOWOFF PIPE

When the boiler is blown down, the expansion of the pipe will in the case of the watchman's clock move the rods sufficiently to take an electrical connection at *D* and *E*, and in the second case open the valve *B*, Fig. 2. By experiment the gage can be marked on the pipe or on the glass with paint for minutes, half or quarter minutes, or for inches of water blown down.

The circuit will open in a very short time after the blowoff cock is closed, as the temperature drops very fast for the first 100 degrees.

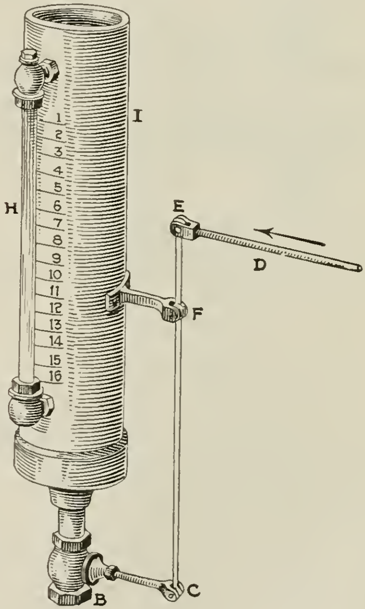


FIG. 2. BLOWDOWN GAGE

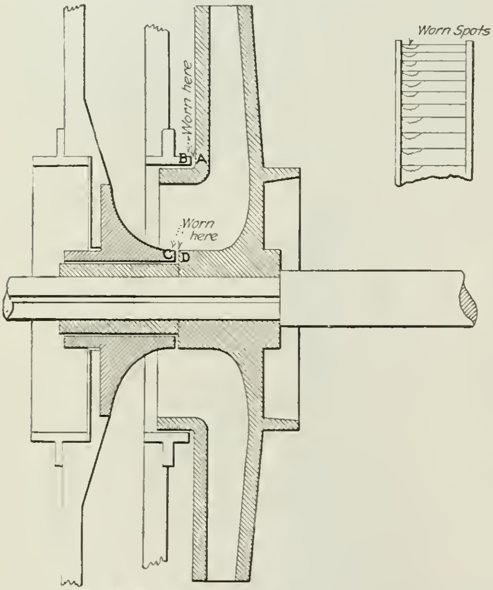
The recorder has another good point—if the blowoff cock leaks enough to heat the pipe or if it should be left slightly open due to scale getting under the valve disk, it will show up the leak. JAMES E. NOBLE.

Kingston, Ont., Canada.

Repairing a Turbine-Driven Centrifugal Pump

The following account of trouble with a centrifugal pump and a description of the method of repair may be of interest to readers of *Power*. The pump is a four-stage centrifugal used for boiler feeding and for operating a turbine cleaner for boring boiler tubes at such times as it is necessary. The speed is 2100 r.p.m. and the pump was built to deliver about 200 gal. per minute at a pressure of 200 lb. It had operated satisfactorily until about two months ago, when a marked falling off in capacity was observed and it was decided to give it a thorough overhauling as no one had any recollection of its being opened up since its installation several years ago.

This statement will be less wondered at when it is explained that the pump was not built with a split casing and required the breaking of the suction line, the removal of the end casting of the casing and the removal of three castings per stage which formed the suction ring and diffusion vanes for each stage, as well as the removal of the rotors from the shaft as fast as each separate stage was reached.



WORN IMPELLER AND TURBINE ROTOR

The thrust bearing was at the extreme end of the shaft at the suction end, and when it was removed the cause of the trouble was apparent, as the bearing had at some time run hot, which had softened the metal and allowed it to yield to the pressure exerted by the thrust, thus permitting the whole rotating element to pull endwise about one-quarter inch, which had the effect of reducing the discharge opening from each stage about one-half, thus accounting for the reduction in capacity.

When the end casting was removed, our real troubles began. The castings comprising the suction ring and diffusion vanes are about 30 in. in diameter and are a tight fit inside the pump casing, necessitating the use of six ¾-in. pulling rods on each disk and the heating of the outside of the casing, the latter being accomplished with the aid of a perforated section of an old steam hose which was tightly lashed to the casing, liberally covered with old burlap and connected to a steam line. After the pump was thoroughly heated, the pulling rods were taken up tight enough to remove the disks.

When the disks and pump rotors were all removed, it was discovered that the impellers were badly worn on the suction side, as shown in the illustration at *A*, *B*, *C* and *D*, which also shows the wear on the renewable sealing rings and suction ring, this wear being caused by the rotating parts pulling endwise when the thrust bearing let go. The impellers did not show any wear due to erosion, so it was decided to repair them in our own shop by filling in the worn places with bronze.

By reference to a cut of the pump and measurements taken from the diaphragms the total end clearance was determined to be $\frac{7}{64}$ in., and the impellers and sealing rings were finished to give that clearance. A new shaft was made to the same dimensions as the old one, and as it was thought best to try the pump for end clearance before assembling it in place, it was assembled on the shop floor and the end clearance was found to be ¼ in. The parts were assembled in the casing, all the connections made, and the shaft was then pushed as far as it would go toward the discharge end and the shaft marked in line with the end of the outboard bearing nearest the thrust bearing. Then it was pushed as far as it would go toward the suction end and the shaft marked at the end of the same bearing. The distance between these two marks was a measure of the end clearance, and it was found to be the same as when assembled on the shop floor. The clearance was then split and a new mark made on the shaft one-half the distance between the other two and the shaft pushed toward the discharge end until the new mark was even with the end of the bearing. A new thrust bearing was then put in place and shims placed between it and the end of the outboard bearing to bring the center mark in line with the end of the bearing.

When the pump was started we had no trouble in bringing it to its rated capacity; the expense was about one-third the cost of new running parts. The filling in of the impellers was done with an oxyacetylene-welding outfit. Another job done at the same time to the blading of the turbine that drives the pump may also prove of interest. It consisted of welding Tobin-bronze sections onto the blades at the point where the steam strikes the blade which had become worn by the action of wet steam (see insert illustration).

The worn places were about ¼ in. deep and ⅜ in. long and were filled in and then dressed down by hand to conform to the shape of the blade.

Only one or two blades in a place were done at a time, the wheel being turned to a new position to avoid undue heating and consequent warping of the wheel.

After the job was completed, the wheel and shaft were placed on balancing ways, but the wheel balanced so well that nothing was done to it to improve the balance.

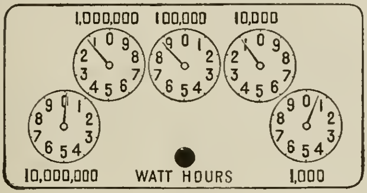
This is the first repair of this kind of which I know, and if it proves to be a permanent job it will mean a saving of about $60 over cost of new blading and a saving of $80 over the cost of a new wheel. The set runs at 2100 r.p.m. without vibration.

Holyoke, Mass. C. B. Hudson.

What Does the Meter Read?

The reading of watt-hour meters is something that is of interest to about everyone, no matter what may be his position, and the interest to operating engineers and electricians was shown in the June 17 issue of *Power* by the large number of answers submitted to the problem, "What Does the Meter Read?" To keep up the interest and give the readers of your publication another chance to test their ability to correctly read a tricky arrangement of watt-hour meter dials, I am submitting the problem shown in the figure. This is one that showed me that I needed a little more experience in meter reading before I could be sure of reading them correctly in every case. A. A. FREDERICKS.

Chicago, Ill.



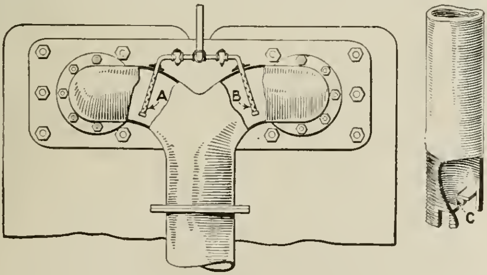
WATT-HOUR METER DIALS

Exhaust-Pipe Spray Pipes Clogged

The illustration shows an exhaust pipe on a blast-furnace gas engine in which trouble was had with the sprays *A* and *B* clogging with mud and scale, and created a good deal of inconvenience.

The exhaust pipes are 26 in. in diameter, and a 1-in. pipe extends down into the exhaust, from the top, to a depth of 20 in. as shown at *A* and *B*. Each pipe contained thirty-six ⅛-in. holes, the inner ends being plugged. This gave the desired spray effect as long as the small holes were free from mud, but after being in use awhile it was necessary to shut down in order to clean out the sprays.

We finally removed the old spray pipes, and instead of putting in another set of pipes of the same design, we upset the internal edge of a 1-in. pipe, as shown at *C*, where it enters the flange on top of the exhaust pipe. No originality is claimed, but we thought it might help some unlucky engineer who is fighting hot exhaust manifolds on large gas engines. To get the best results with the pipe cut as at *C*, cut about 1½ in. of threads on the pipe, and with a hacksaw cut two slots in the end of the pipe, ½ in. deep and ¼ in. apart, and bend the two narrow strips in toward the center.



OLD AND NEW SPRAY PIPES

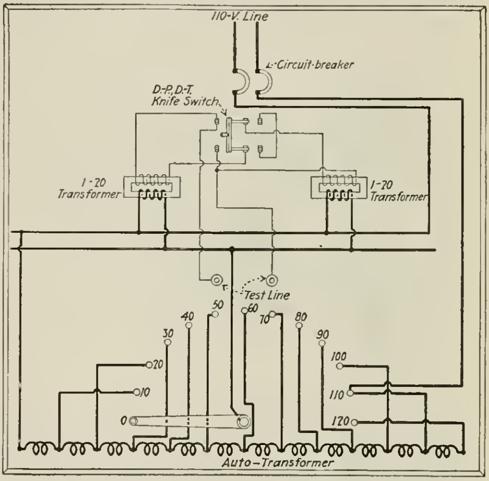
The pressure of the exhaust discharge, together with the split stream of water striking the exhaust at right angles, will make sufficient spray to keep the exhaust pipes cool. A. L. FRITZ.

South Chicago, Ill.

Insulation-Testing Panel

It is almost a necessity around an electric shop to have some convenient means of applying voltages of two or three times the working voltages to motors, transformers, etc., that are being repaired. I have in my shop such a test panel made from materials that can be found easily and it fills the need nicely.

A discarded switchboard panel was utilized, on which was mounted the equipment, consisting of a circuit-breaker, a double-pole double-throw knife switch, two standard instrument potential transformers, a sign-lighting transformer with 13 taps, a dial switch, and two receptacles for the insertion of the high-potential test lines. The arrangement can easily be followed from the figure. At the top is mounted the circuit-breaker through which the 110-volt alternating-current line feeds; then the switch, which, when thrown to the left puts the transformers 2000-volt windings in parallel, and to the right in series. Since the sign-lighting transformer is really an auto-transformer, the voltage applied to the low side of the potential transformers is easily varied by means of the dial switch, and thus by manipulating the knife and dial switches any voltage from 0 to 2400 may be obtained in 200-volt steps, or by throwing the knife switch to the right any voltage from 0 to 4800 may be obtained in 400-volt steps. The circuit-breaker is set to trip on a failure of the insulation under test.



WIRING DIAGRAM OF TESTING PANEL

This outfit works very well on apparatus that is not too large. On large equipment that might have considerable electrostatic capacity, it would of course be too small, but for the average shop it is all right.

J. M. WAUCHOPE,
Chief Electrician
International Smelting Co.

Tooele, Utah.

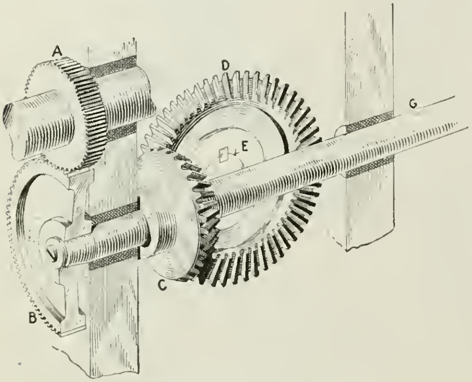
Some Gas-Engine Troubles

At one time I had charge of a plant consisting of four large gas-engine units—one three years old and in comparatively good condition, and the others about eight years old and in bad shape.

Three of the units were required to carry the load, and by keeping the new engine on all the time and switching out one of the old ones that happened to be in the worst shape, we had begun to improve the conditions of the old one and were hoping to have it easier.

The new unit was known as the No. 4 and the old units, Nos. 2, 3 and 1 respectively. The outside of both cylinders being badly cracked, we had just got No. 3 in pretty good shape mechanically and had it on the board with the other three units for a tryout, when without warning, the 2 to 1 gears on No. 4 crashed out through the gear case and the flywheel kicked the pieces promiscuously around the power house.

We had a heart-breaking time trying to keep the power on with the three old units until we could get new gears for the good engine. A set of gears had never been broken in the history of the plant, and a pair was not carried in stock, so we had to order from the engine builders. A pair was also ordered made at a local shop. Both sets came at about the same time, and as one of the engine builders' gears was a little bit faulty, one of the locally made gears was put on with one of the builders' gears, and the good unit put back in service.



LAYOUT OF ENGINE GEARING

The cracked cylinders were leaking so badly on No. 3 by this time that we had to cut it out of service as soon as we could tinker up the other two old units so that they looked halfway safe, and put on a new pair of cylinders.

This was a long job, and before we could finish it, we lost another set of gears on the good engine. We worked all night to get the faulty gear supplied by the engine company and the other machine-shop gear on in time for the Fourth of July load. It ran for about twenty-four hours and broke up this set, but we hurriedly finished the No. 3 job and got it back under load.

The construction of the reducing mechanism on the engine was as shown in the accompanying sketch. The main shaft was 18 in. in diameter and carried the spur gear *A*, which meshed with the spur gear *B* on what was known as the cross-shaft *G*. The cross-shaft carried a bevel pinion *C* which meshed with a bevel gear *D* on the camshaft *E*. A thrust washer between the engine frame and the pinion *C* held it in mesh with the gear *D*. The spur gear *B* was bored on a taper and pressed on the shaft and keyed with a screw. When putting on the last set of gears, it was noticed that the gear *B* did not go clear on and that there was about ¼ in. clearance between the hub and the frame, and someone suggested that it might have something to do with our trouble.

I reasoned that all the thrust would come against the hub of the pinion *C*, but a drowning man will grab at a straw, and as the other gears that broke did not fit up any closer, the order was given to take time to turn the shaft down till there was one thirty-second clearance between the engine frame and the gear.

I could not say that this was what caused us to lose three sets of gears on this engine, but I do know that we had no further trouble while I was at the plant and to my knowledge there has been none since, so it seems reasonable to assume that the end play of the cross-shaft allowed the bevel gear and pinion to mesh too deep, and as the bevel and pinion were steel and the spur gears cast iron, the latter gave way.

I might add that upon investigation it developed that the original cross-shaft had been broken and that a new one had been made locally, which accounts for the gears not going on far enough to allow the proper clearance between the gear hub and the engine frame.

Cherryvale, Kan. EARL PAGETT.

Superheated Steam in Reciprocating Engines

In your issue of July 1, 1919, you inquire as to be use of superheated steam in reciprocating engines. Locomotives furnish the greatest example of such use, for none are built in this country or Canada that do not use highly superheated steam. Moreover, old locomotives are altered to superheaters, and even switching engines are made superheating. Probably it would not be far from the mark to say that there are no saturated-steam locomotives in use in this country. Such locomotives displaced compound locomotives except those of the Mallet type and a few others here and there.

The railroads have had their troubles in developing the use of superheated steam, but with improved lubricants, and metal for cylinder and valve bushings and piston rings, and the use of piston valves (although superheat with slide valves is used), they are out of the woods.

In stationary practice no doubt there are many cases of the use of highly superheated steam in reciprocating engines, but I have used it in pumping and mill engines having Corliss valves, and nothing but a proper lubricant has been necessary for success. The superheat that comes from vertical fire-tube boilers is used in countless reciprocating engines and is a source of some economy. In marine work a superheat of 50 deg. at the boilers is common in ships having reciprocating engines.

On the whole it is safe to say that turbines are not necessary for the use of highly superheated steam, and even they have come to grief from its use in many cases.

Philadelphia, Penn. F. W. DEAN.

Inquiries of General Interest

Test for Acid in Oil—What test of oil can be made for determining the presence of acid? W. R.

Acid may be readily detected by thoroughly mixing a small amount of the oil with an equal quantity of pure warm water. The mixture may then be tested with neutral litmus paper. If acid is present the paper will immediately turn red. The sensitiveness of the paper may be increased by exposing it to fumes of nitric or muriatic acid until it becomes partly red. After the paper thus treated is dried, and part of its surface is immersed in the mixture of water with oil to be tested, the presence of a very small amount of acid will cause the part of the paper immersed to turn a shade darker than the rest.

Size of Ground Wires—For grounding the frames of electrical equipment, what size of ground wire should be used? M. C. R.

Rule 15A(m) of the 1918 edition of the National Electrical Code recommends that with portable equipment protected by fuses not greater than 15 amperes No. 14 ground wire be used. For stationary equipment the protection of which does not exceed 100 amperes a No. 10 B. & S. ground conductor is required. With the nearest cutout protecting the equipment having a capacity of 101 to 200 amperes, use No. 6 B. & S.; where the protection is from 201 to 500 amperes capacity the ground conductor should be a No. 4 B. & S.; above 500 amperes a No. 2 B. & S. conductor is required.

Smokeless Chimney Not Conclusive Proof of Furnace Economy—Is absence of smoke an indication of economical operation of a boiler furnace? W. L. R.

Smokeless combustion indicates more economical operation only when attended by complete combustion of the fuel without too great excess air, and absence of smoke is not conclusive proof that the furnace is being operated in the most economical manner. A very great excess of air may so dilute the smoke as to make it almost invisible, but the efficiency will be low, for under such conditions the furnace temperature is lowered and a large amount of heat is wasted in raising the temperature of the excess air. The true test of economical operation of a boiler furnace is analysis of the flue gas, by which not over 100 per cent. of excess air should be shown.

Use of Sticking Safety Valve—When pressure on a boiler exceeds the allowed pressure from sticking of the safety valve, what should be done to relieve the pressure and how should sticking of a safety valve be guarded against? R. G.

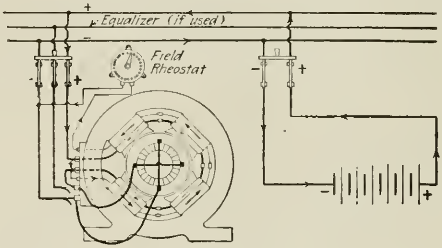
Whenever the boiler pressure is in excess of the allowed pressure, to reduce the pressure increase the speed of the feed pump, close the damper, open as many small outlets for the steam as possible and start slowly all pumps, engines or other available steam apparatus. When the pressure is about normal, slowly lift the safety valve by hand. To guard against sticking of a safety valve it should be allowed to blow at least once a day by raising the pressure to the blowoff pressure, and if there is more than 5 lb. in variation of the blowoff pressure for the same setting. the valve should be thoroughly cleaned and repaired to prevent sticking.

Setting of Piston Valve Having Inside Admission—How would you set a piston valve taking steam in the center, if the valve is connected directly to the eccentric without reversing rocker; and would the eccentric lead or follow the crank, and how much? J. N. A.

Adjust the length of the valve rod or its connections with the eccentric to obtain the same amount of travel of each inside edge of the valve away from the inside edge of its steam port. As in opening, the movement of the valve is opposite to the direction of motion of the piston, when the valve is directly connected the eccentric should be set to follow the crank. If there is no lap or lead the eccentric would be set 90 deg. behind the crank. The angle of advance would be the number of degrees the eccentric would be less than 90 degrees behind the crank for obtaining the desired amount of lead, so that for an inside admission valve with the eccentric directly connected, the eccentric must be set to follow the crank 90 deg. less the angle of advance.

Changing Generator's Polarity—We have a 110-volt storage battery operating in parallel with a 110-volt compound-wound generator. If the polarity of the generator becomes reversed what is the easiest way to establish correct conditions? J. A. W.

One of the best ways to correct the polarity of a generator that has been reversed when operating in parallel with other machines is to open the armature circuit at the machine, the polarity of which is to be corrected, and close its switch to the bus. The connection for this purpose is shown in the figure. This connection will always establish a polarity of the field poles that will bring the generator's voltage up the same polarity as the busbars. Care should be exercised to see that the armature circuit is open, since connecting a dead machine to a live bus is liable to cause serious damage.



Percentage Speed Regulation—What is meant by percentage regulation of a prime mover? E. E. R.

In steam engines, steam turbines and internal-combustion engines, the percentage speed regulation is usually expressed as the percentage ratio of the maximum variation of speed to the rated-load speed, in passing slowly from rated load to no load with constant conditions at the supply. Thus if an engine is carrying full load and the rated-load speed is 200 r.p.m. and the speed increases to 208 r.p.m. when the load is gradually removed, while supplied with steam at the same pressure, the percentage speed regulation would be $8 \times 100 \div 200 = 4$ per cent. If the test is made by suddenly passing from rated load to no load, the percentage speed regulation so derived is termed the "fluctuation." In a hydraulic turbine or other water motor, the governor operates the supply gates only when the normal speed is not satisfied, and the percentage speed regulation is the percentage ratio of the maximum variation of speed, in passing slowly from rated load to no load (with constant head of water) to the rated-load speed.

[Correspondents sending in inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Uses of Superheated Steam*

By Alexander Bradley†

A brief history of the development of superheating, with the results of tests which tend to show the saving of fuel that can be realized by the installation of a properly designed superheater.

In 1705 Denys Papin, the French physicist, made what was probably the first application of superheated steam. By placing a mass of heated metal in a recess of the piston, on the steam side, of Dr. Avery's engine, or pump, he reduced the condensation of the working steam and produced what was in effect a superheater. A certain Captain MacGregor in Cornwall, England, in 1828, built a brick jacket around the cylinder and the steam pipe of his pumping engine; he left a space, or flue, between the brick and the metal, and by maintaining a fire in this space he reduced the steam consumption of his engine to a remarkable extent.

Until about 1870 engineers took great interest in superheated steam. Ericson, Hirn and Isherwood conducted many experiments, securing excellent results. During this period most of the superheaters were installed in connection with marine boilers.

However, about this time vast improvements in the steam engine were introduced—namely compounding, condensing, improved valve gears and, last but not least, higher steam pressures. These improvements, together with the troubles encountered in stuffing-boxes, gaskets and lubrication on superheated steam, tended to limit its use for a number of years. In 1874 Dr. Kirk introduced the triple expansion engine, and it soon became the standard type of marine engine. The steam pressure was still further increased and consequently the temperature, thus militating against superheating under the then existing conditions.

Hirn continued his experiments and in 1892 in a series of tests showed a saving in fuel of 20 per cent. with the superheater installed within the boiler setting. He superheated the steam to from 86 to 113 deg. F. His successors, Schwoerer, Schröter and Schmidt, made rapid strides in again bringing superheating into use. In 1895 Schmidt built a boiler and engine for use with superheated steam, and Prof. Schröter's tests showed that it developed an indicated horsepower upon 10.4 lb. of steam per hour, or about 1.3 lb. of coal. The steam presure was 156 lb. and the superheat 189 deg.

This was a remarkable performance, especially as the engine was of only 75 hp. Soon after the reports of this and other tests were published, interest in superheating rapidly revived, especially in Europe. Lubricating oils, packings and gaskets were brought out which gave perfect satisfaction on superheated steam. During the last ten years pressures have been steadily increasing as has also the amount of superheating, resulting in higher final temperatures.

At about 600 deg. F. cast-iron fittings and valves when used on superheated steam at the present high pressures, are apt to "grow" or expand and then take a permanent set. At somewhat higher temperatures the cast iron begins to lose its strength and becomes in time unable to withstand the pressure. Much apparently conflicting evidence has been submitted upon this subject. After an experience of fifteen years with superheaters and superheating the truth appears to be that cast-iron fittings and valves give good service on superheated steam at 500 to 550 deg. F. if built in the first place of good gray iron and of the proper strength to carry the pressure. If, however, a superheater is employed which gives wide fluctuations in the degree of superheat, the cast iron will "grow" and become "fatigued" in time.

There are many plants that have been in operation for ten years or so, where the cast-iron fittings and valves are still giving good service, and that with pressures up to 175 lb. and superheating up to a final temperature of 525 to 550 deg. F. Until the last few years, cast iron has been the only metal used for this purpose in Europe, where they employ higher pressures and higher superheat than we do in this country, though it should be stated that they claim to be able to produce a much better grade of cast iron than is made here.

Steam, at any given pressure, is said to be saturated so long as it remains in contact with the water from which it is evaporated. If it is now separated from the water and more heat added to it, its temperature increases, it becomes practically a perfect gas and is said to be superheated.

The specific heat of superheated steam, that is the heat required to raise one pound one degree, varies with the pressure and also with the temperature; it increases with the pressure, but decreases as the temperature becomes higher. At 50 lb. absolute pressure the specific heat is 0.498 for 100 deg. superheat, and 0.491 for 200 deg. superheat; while at 250 lb. absolute pressure it is 0.615 for 100 deg. superheat, and 0.562 for 200 deg. superheat.

Being practically a perfect gas, superheated steam follows the laws of gases, its volume increasing with the increase in temperature, and in direct proportion to the absolute temperature. As an example of this characteristic saturated steam at 150 lb. pressure and an absolute temperature of 826 deg. has a volume of 2.75 cu. ft per pound. If this steam is superheated 100 deg. the absolute temperature increases to 926 deg. while the volume increases to 3.08 cu. ft., an increase in volume of 12 per cent. The heat added has been that amount which is necessary to raise the temperature 100 deg., and as the specific heat of superheated steam at 150 lb. pressure and 100 deg. superheat is 0.566, this amount is 56.6 B.t.u. The total heat of saturated steam at 150 lb. pressure is 1227 B.t.u. above zero, hence the 12 per cent. increase in volume has been obtained by increasing the total heat by only 4.6 per cent.

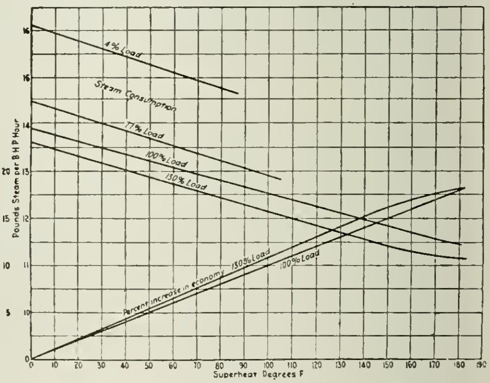


FIG. 1. RELATION OF SUPERHEAT TO ECONOMY FOR A 400-KW. WESTINGHOUSE-PARSONS TURBINE

Steam at any pressure can be superheated, and so long as it remains in connection with the source of supply of saturated steam, the pressure will not increase. As this is the usual operating condition, it may be stated that superheating steam does not increase its pressure.

The following example will serve to show how superheating reduces the steam consumption of an engine: In a certain engine (Schmidt) it was found that for each 1 per cent. of wetness, or steam condensed at the point of cutoff, when using saturated steam, it required 7.5 deg. superheat in the entering steam to prevent condensation up to that point. Thus, in case 25 per cent. of the saturated steam condensed at cutoff, there would be required 7.5 deg. ×25= 187.5 deg. of superheat in order for it to be dry at at that stage. Suppose, then, it takes a pound of steam to fill this cylinder at cutoff, which would require for its production 1000 B.t.u.; in the first case since 25 per cent. condensation took place, a total of 1⅓ lb. was admitted, to produce which takes 1333 B.t.u.; in the second case in addition to the 1000 B.t.u. to produce the steam sufficient heat must be added to superheat it 187.5 deg. and taking the specific heat at 0.48, 90 B.t.u. additional are required.

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*Abstracted from paper presented at the Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, Pittsburgh, Penn., June, 1919.

†Power Specialty Co., 111 Broadway, New York, N. Y.

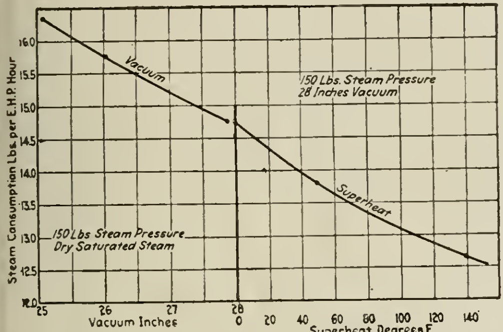

FIG. 2. EFFECT OF VACUUM AND SUPERHEAT ON STEAM CONSUMPTION OF A 1500-KW. TURBINE AT FULL LOAD

Since the work performed can be said to be the same in both cases, the heat required is 1333 B.t.u. in the first case and 1090 B.t.u. in the second, or a saving of 23.3 per cent. of the steam by superheating. Thus in an engine, superheating saves by reducing condensation of the steam and loss by radiation through the cylinder walls. On turbines superheated steam shows a decided saving, reduces the wear of the blading to a minimum, and increases the capacity in horsepower.

Fig. 1 gives the relation of superheat to economy on a 400-kw. Westinghouse turbine. Fig. 2 is interesting in that it shows the saving made in a turbine by a vacuum up to 28 in. and by superheating to 150 deg.

In both engines and turbines, however, the guarantees of the builders and the basis of comparisons are upon dry saturated steam upon one hand and superheated steam upon the other. As a matter of fact saturated steam always carries water in actual practice; generally it is found to be what is termed commercially dry and contains about 2 per cent. of water. For each 1 per cent. of water the builder demands a correction in his saturated-steam consumption of 2 per cent. Any reputable builder of turbines or engines will today guarantee 10 per cent. of steam saving if given 100 deg. superheat as compared with dry saturated steam. Therefore as there is in practice 2 per cent. water, 4 per cent. is gained by eliminating the water which, plus 10 per cent. equals 14 per cent., the saving with 100 deg. superheat.

Fig. 4 shows some curves worked out to illustrate the saving in both steam and fuel by superheating—when the saturated steam is dry as well as when it carries 1 per cent. water.

Experience with several hundred engines of the Corliss and slide-valve types indicates that with steam pressure up to 200 lb. it is practical and very beneficial to superheat the steam up to a final temperature of 475 to 500 deg. F., which generally means that there will be a temperature in the steam at the throttle of the engine of from 450 to 475 deg. Piston-valve and poppet-valve engines admit of carrying the superheat much higher and with good economy, although it is generally found that the first 75 to 100 deg. of superheat effects a greater economy than any succeeding like amount.

In a general way it may be stated that the saving in steam and in fuel by using superheated steam on reciprocating engines, pumps and compressors, is as follows, assumings 100 deg. superheat as an amount most frequently used:

	Steam Saving, per Cent.	Fuel Saving, per Cent
Simple engines and compressors	18	13.5
Compound engines and compressors	14	10.5
Triple engines and compressors.	12	9.0
Simple direct-acting pumps	22	16.5
Compound direct-acting pumps	18	13.5
Triple direct-acting pumps	16	12.0

A few years ago a comparative test was run by the engineers of the United States Steel Corporation at one of its plants in order to ascertain what saving could be made in the steam consumption of a large Allis-Chalmers cross-compound blowing engine. The result showed an average saving of 13.33 per cent. with 113 deg. superheat, and this, too, upon a very economical engine. There were several different types of engines tested, and the entire series were very well conducted and the results most interesting. The Standard Oil Co. recently ran a series of comparative tests at its Malby station on direct-acting triple-expansion oil-pumping engines. Fig. 3 gives the results obtained in two groups of curves, one on saturated steam, the other on superheated steam. The results were highly satisfactory as the curves show—at the average power load on the plant the saving in water fed to the boilers (this plant is in the desert) was 20.5 per cent., the saving in dry steam on the main pumps was 10.93 per cent. and in fuel (dry oil) fed to the boilers 15.95 per cent.

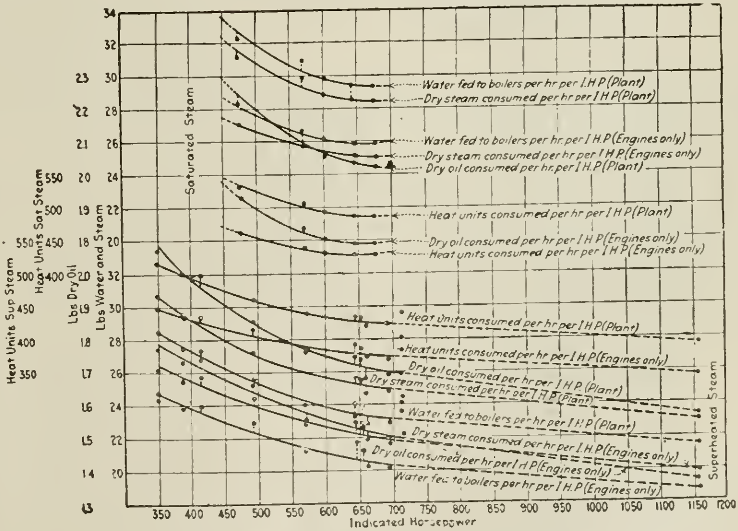

FIG. 3. RESULTS OF COMPARATIVE TESTS ON OIL-PUMPING ENGINES WITH SATURATED AND SUPERHEATED STEAM

It should be borne in mind that the total saving is not made in the prime movers, to be mostly offset by the cost of the additional fuel required to obtain the superheat. A properly designed superheater attached within the setting of a boiler always results in at least as good an efficiency for the combined boiler and superheater as for the boiler alone; generally, the combined efficiency is higher, and often to such an extent that the first 50 deg. of superheat are obtained without the expenditure of additional fuel.

Being a perfect gas, superheated steam can be put through pipes at a higher velocity than is possible with saturated steam at the same pressure. This means smaller pipes and fittings at a corresponding saving in this material. The loss in pressure in a long pipe line is also less when the steam is superheated.

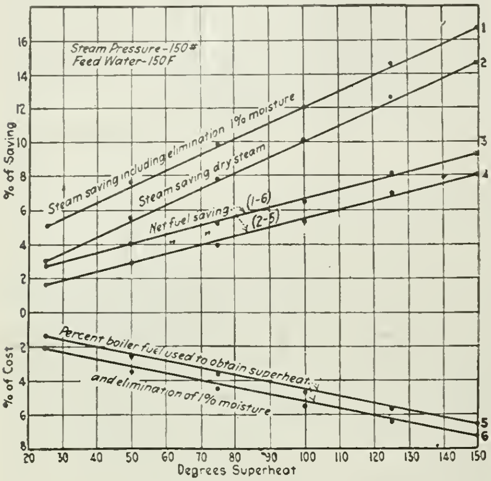

FIG. 4. DIAGRAM SHOWING SAVINGS DUE TO SUPERHEAT IN TURBINES

During the past few years a number of interesting uses for superheated steam have been developed. The Peoples Gas Light and Coke Co., of Chicago, is blowing its water-gas generators with superheated exhaust steam at about 2.5 lb. pressure, instead of using live steam as heretofore. The saving averages 20 per cent. with a satisfactory increase in the capacity of the generators themselves. The use of superheated steam has been successfully introduced in the manufacture of wood pulp. Also textile mills, sugar mills, oil refineries, salt works and plants of a similar nature have found that it pays.

Proposed Legislation to Strengthen Patent Office

As is known to representatives on Engineering Council, the Patents Committee of Council has collaborated with the similar committee of National Research Council in developing a scheme for the improvement of the method of dealing with patents in this country. The staff of the Patent Office is itself actively engaged in this effort. Out of the report prepared by the National Research Council, and approved and adopted by Engineering Council as the report also of its Patents Committee, remedial legislation has taken form. Three bills have been introduced, known as H. R. 5011, a bill to make the Patent Office independent of the Department of the Interior or any other department, and to simplify the procedure of the Courts with reference to assessment of damages or profits for infringement of patents; H. R. 5012, a bill to establish a single Court of Patent Appeals; and H. R. 7010, a bill to increase the force and salaries in the Patent Office.

Oxy-Acetylene Welding*

By Alfred S. Kinney †

Up to the advent of autogenous welding the engineer had only his experience with the forge weld upon which to base his calculations and judgment. In a way this proved somewhat unfortunate for the new method of welding, as the forge weld had nearly lost its value as a dependable means of joining materials. Imagine two pieces of steel being brought to a soft plastic condition in a forge fire charged with sulphur from the fuel, an excess of oxygen from the indifferently operated bellows or fan blower, the cinders and refuse of the fuel, and one can readily realize the cause of weak forge welds. Such welds never were reckoned to have a tensile efficiency of more than about 50 per cent., and many observations of welds which had failed showed crystallization and even entrapped cinders. Navy yards and many other large shops had practically abandoned the forge weld, preferring the expensive substitute of machining a job out of the solid when it was possible to do so.

Then, too, in those earlier days the only metals which could be welded were wrought iron and steel. There was no way to weld cast iron and the non-ferrous metals like copper, brass, aluminum.

Then came autogenous welding and cutting by the oxy-hydrogen process, soon to be superseded by oxy-acetylene, thanks to the electric furnace's efficient method of producing calcium carbide and making acetylene a commercial possibility. From that time—practically only about fifteen years ago—metal workers, manufacturers, engineers—nearly the whole industrial world have eagerly watched the progress of the oxy-acetylene process.

Conditions of Metal Contrasted

The mechanical engineer recognized at once that certain fundamental principles were involved in oxy-acetylene welding which were new to shop practice. The old method required that the metal be heated merely to a soft pasty condition and then hammered or pressed together, while the new way was to melt the metal and flow the two ends into one mass. By the former method there would not be a thorough mingling of the grains of the metal, and every opportunity for such a weld to receive gas and fuel impurities from the forge fire. By the new process there could be nearly perfect rearrangement of the grains due to the liquid condition of the metal. The mechanical engineer recognized at once, however, that while the fusion of castings for welding would be consistent with the method of their formation, that is, that both the original metal and the weld itself would be in the cast condition, this would not be true in the case of the welding of rolled or forged iron or steel. There the two pieces of rolled or forged metal would be joined by a cast weld, the former being fine grained and strong, the latter of coarse grains and reduced tensile strength. This was not a new situation to the engineer. The benefits derived from hammer-refining the grains of steel are well known. An ordinary machinist hammer therefore proved to be the cure of this trouble, and it may be of interest to relate that in some experiments performed during the past year by the author, some worn railroad frogs which were built up by the oxy-acetylene process, and allowed to cool directly from the liquid to the solid condition lasted only a few weeks in service, but when a progressive method of building up and hammering was resorted to some of the frogs lasted over nine months in continuous severe service.

As fusion was the chief requisite of a good weld, the new process might be used to join other metals than wrought iron and steel. This opened up wonderful possibilities, new indeed to welders, for cast iron and the non-ferrous metals had not yet been welded. Would it be possible for the new welders to learn the marked differences of characteristics of steel, cast iron, copper, brass, aluminum? We have but to call to mind the work being done in the welding of iron castings alone to get an answer and to form an idea of the possibilities and value of the oxy-acetylene process for the welding of cast iron. The author recently had to do with the oxy-acetylene welding of three broken cast iron cylinders of freight locomotives, which cost $515 to weld and put in good working order, but would have cost $3,600 to replace by new cylinders if oxy-acetylene welding had not been available, leaving out of consideration the long delay in getting the locomotives back in service by the old method of making repairs, as compared with the few days lay up for welding.

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*From an address before the International Acetylene Association.

†Professor of Shop Practice, Stevens Institute of Technology and Advisory Engineer Air Reduction Company.

The gases used in an oxy-acetylene torch operated by inexperienced welders might easily be made to lower the value of the weld. Many of the first oxy-acetylene welds were badly crystallized. The engineer knew this and waited for developments. The first designs of torches were much to blame for this condition, but the inexperience of the welder was more so. It is not unusual now to find oxy-acetylene welds so homogeneous as to make it practically impossible to see any difference between the original material and its weld.

Unusual problems of expansion and contraction must be reckoned with in the job welded by oxy-acetylene. No one would attempt to dispute this. The cautiousness of the engineer in this regard may well be understood. It has required an experimental experience to master these difficulties, but they do not stand in our way now.

Proper Training of Workmen Essential

The heating of the oxy-acetylene weld was accomplished by the powerful quick-acting flame instead of a slow forge fire. It was readily seen that a trained eye would be required to bring about good results from the working of the metal in the molten conditions. What would happen if the metal were overheated? What if the original metal were not thoroughly melted when the molten rod was dropped upon it? A man must know more than a blacksmith about hot metals to be an oxy-acetylene welder. Could such men be secured and could their skill be relied upon? We know the answers to these questions now, but they recall to some at least the time of not so long ago when the mechanical engineer struggled with his welders to teach them the difference between molten metal and burnt metal. We venture to say that it will be much easier to make good oxy-acetylene welders from now on than it has been heretofore.

To continue this subject a bit further it will be apropos to call attention to the attitude of the technical engineer toward the teaching of the oxy-acetylene processes in the engineering colleges. Some of these institutions were not slow to grasp the importance of the subject. The Stevens Institute of Technology was probably the first college to take up the work. The author has lectured for about ten years on the subject as head of the Department of Shop Practices in that institution, and some time ago we added a course of jobs to be welded by the oxy-acetylene torch which every student at Stevens has been required to take. We have heard of other engineering colleges who have introduced such a course, and we understand that Harvard's new engineering school is about to include oxy-acetylene welding in the instruction of its shop department.

Abroad in the world of engineering construction and repairs the technical engineer has been giving careful thought to the possibilities and advantages of oxy-acetylene welding. He has encouraged its trial in shop, foundry, and manufacturing plant. He has studied its evolution from the rough joint of doubtful value to the homogeneous weld of nearly 100 per cent efficiency. If he has been conservative in his judgment it was because he knew better than others of the undeveloped parts of the new field being entered by the welder; if he has appeared to be slow to accept the process for the most important high pressure and high tension work it is because he has waited to prove that the new welder could measure up to his increased responsibility. One thing he will not do: he will not forget the inherent crudeness of the work, nor the varying personal error of the workmen, and expect impractical refinements.

The Production of Electric Power

The United States Geological Survey has issued a bulletin in which the production of electric power and consumption of fuel by public utility power plants in this country is given for the month of March, 1919.

The report is based on returns received from 3075 electric power plants engaged in public service, including central stations, electric railways, and certain other plants, the output of which contributes to the public supply. Returns were received from plants representing about 89 per cent. of the total generating capacity. For those plants which did not submit returns or were unable to furnish their output, estimates of the output were made as accurately as possible from available information. The output for the month averages 101,400,000 kilowatt-hours per day of which 41 per cent. was produced by water power. The average consumption of coal per kilowatt-hour of plants using coal, which made returns, was about 3 pounds.

THOUSANDS OF KILOWATT HOURS PRODUCED

State	By Water-Power	By Fuels	State	By Water-Power	By Fuels
Alabama	30,275	4,907	Nevada	2,450	121
Arizona	6,689	21,807	New Hampshire	7,971	1,958
Arkansas	72	6,620	New Jersey	197	76,775
California	215,914	33,939	New Mexico	56	1,556
Colorado	14,254	17,144	New York	222,318	288,191
Connecticut	14,884	37,469	North Carolina	46,333	7,426
Delaware	0	4,784	North Dakota	0	2,453
District of Columbia	0	19,172	Ohio	3,932	194,850
Florida	892	8,789	Oklahoma	183	12,981
Georgia	37,264	6,082	Oregon	29,014	3,779
Idaho	39,913	257	Pennsylvania	62,509	246,989
Illinois	15,282	207,705	Rhode Island	805	18,405
Indiana	3,648	54,613	South Carolina	43,417	4,045
Iowa	48,502	25,051	South Dakota	3,579	4,042
Kansas	1,223	30,775	Tennessee	45,222	10,680
Kentucky	4	19,127	Texas	200	48,034
Louisiana	0	14,866	Utah	15,463	0
Maine	20,157	73	Vermont	18,393	179
Maryland	371	13,898	Virginia	20,221	18,774
Massachusetts	31,365	100,034	Washington	79,347	4,521
Michigan	59,650	96,101	West Virginia	1,593	58,108
Minnesota	34,881	16,848	Wisconsin	37,569	33,053
Mississippi	0	5,399	Wyoming	172	3,898
Missouri	5,920	38,396			
Montana	77,861	854	Total	1,300,924	1,842,214
Nebraska	959	16,687	Combined total		3,143,138

FUEL CONSUMPTION

State	Coal, Short Tons	Petroleum and Derivatives, Barrels	Natural Gas, Thousands of Cubic Feet
Alabama	16,467	0	0
Arizona	6,160	88,011	0
Arkansas	11,177	489	85,398
California	0	185,127	181,785
Colorado	44,079	95	0
Connecticut	62,234	323	12,615*
Delaware	7,713	17	0
District of Columbia	20,483	0	0
Florida	5,594	199,149	151
Georgia	11,934	120	0
Idaho	111	10	0
Illinois	351,289	2,198	0
Indiana	157,896	167	2,108
Iowa	78,739	730	0
Kansas	51,932	60,233	85,996
Kentucky	39,386	351	0
Louisiana	14,560	29,419	47,458
Maine	348	7	0
Maryland	23,657	18	1,500
Massachusetts	143,453	14	0
Michigan	124,841	104	0
Minnesota	46,346	992	0
Mississippi	16,542	349	0
Missouri	90,495	19,580	0
Montana	5,686	563	960
Nebraska	32,984	3,349	0
Nevada	180	1,044	0
New Hampshire	3,696	20	0
New Jersey	116,525	103	0
New Mexico	4,438	1,360	0
New York	363,319	546	164,408
North Carolina	16,234	20	0
North Dakota	17,116	504	0
Ohio	321,987	842	323,020†
Oklahoma	13,153	5,594	440,094
Oregon	433	14,345	0
Pennsylvania	408,264	14	54,450
Rhode Island	22,024	0	0
South Carolina	9,540	33	0
South Dakota	12,325	3,463	0
Tennessee	28,724	84	0
Texas	34,789	181,318	179,760
Utah	61	0	0
Vermont	412	2	0
Virginia	22,475	13	0
Washington	3,473	18,804	0
West Virginia	70,717	58	142,688
Wisconsin	77,139	662	0
Wyoming	19,907	2,539	18,349
Total	2,931,037	822,783	1,740,740

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* Artificial gas. † 67,156 artificial gas.

A. I. E. E. Committee Appointments

At the first meeting of the Board of Directors of the American Institute of Electrical Engineers for the administrative year beginning on Aug. 1, 1919, held in New York, on Tuesday, Aug. 12, 1919, President Townley appointed committees for the administrative year, the chairmen of which are as follows:

Finance, N. A. Carle, Newark, N. J.; Meetings and Papers, W. I. Slichter, New York; Editing, Henry H. Norris, New York; Board of Examiners, F. L. Rhodes, New York; Sections, W. A. Hall, Lynn, Mass.; Student Branches, C. Francis Harding, Lafayette, Ind.; Membership, R. W. Krass, New York; Public Policy, H. W. Buck, New York; Headquarters, N. A. Carle, Newark, N. J.; Committee on Technical Activities, Wilfred Sykes, Pittsburgh; Standards, L. T. Robinson, Schenectady, N. Y.; Power Stations, Philip Torchio, New York; Transmission and Distribution, E. B. Meyer, Newark, N. J.; Traction and Transportation, W. S. Murray, New York; Industrial and Domestic Power, A. G. Pierce, Pittsburgh; Lighting and Illumination, C. E. Clewell, Philadelphia; Economics of Electric Service, William McClellan, Philadelphia; Protective Devices, D. W. Roper, Chicago; Electrochemistry and Electrometallurgy, E. F. Northrup, Princeton, N. J.; Electrophysics, F. W. Peek, Pittsfield, Mass.; Telegraphy and Telephony, Donald McNicol, New York; Marine, Arthur Parker, Camden, N. J.; Use of Electricity in Mines, W. A. Chandler, Uniontown, Pa.; Electrical Machinery, B. A. Behrend, Boston; Instruments and Measurements, S. G. Rhodes, New York; Iron and Steel Industry, W. F. James, Philadelphia; Educational, J. C. Parker, Ann Arbor, Mich.

In accordance with the by-laws of the Edison Medal Committee the board confirmed the appointment by President Townley of three members of that committee for terms of five years each; namely, Messrs. Edw. D. Adams, New York; H. H. Barnes, Jr., New York; and Benjamin G. Lamme, Pittsburgh; the Board also elected three of its own membership as members of the Edison Medal Committee for terms of two years each, namely Messrs. Wilfred Sykes, Pittsburgh; W. A. Hall, Lynn, Mass.; and G. Faccioli, Pittsfield, Mass.

Exports of Electrical Machinery and Appliances for May, 1919*

Countries	Batteries Dollars,	Dynamos and Generators Dollars	Fans Number	Fans Dollars	Incandescent Lamps, Carbon Filament, Number	Incandescent Lamps, Carbon Filament, Dollars	Incandescent Lamps, Metal Filament, Number	Incandescent Lamps, Metal Filament, Dollars	Insulated Wire and Cables, Dollars	Transformers, Dollars	All Other Electrical Machinery, Dollars	Meters and Measuring Instruments, Dollars	Motors, Dollars	Rheostats Controllers, Dollars	Switches and Accessories, Dollars
Belgium	75	15,627			1,000	210	2,000	620	53	2,370	39,177		9,594		45,058
Denmark	2,042						23,000	7,410	9,357	5	18,593	2			
France	3,453	9,528							4,431	5,234	88,712	5,367	20,861	800	14,944
Greece	100								670		1,806		485		
Iceland and Faroe Islands	1,289	2,893					1,300	687	212		1,773		124	350	4,651
Italy	87						77,982	21,796	110		430,407	7,672			
Netherlands									315		1,169				340
Norway	11,420						40	12	133,350	32,831	45,618	71	9,029		7,669
Portugal	12										16				
Spain	1,350	1,605	270	2,395			6,150	1,620		2,198	26,800	484	21,722	50	3,664
Sweden									6,752		38,727		3,169		
Switzerland									49,812		123,213	577	9,178		20,642
England	70,222	2,808					300	700	6,178		39,746	7,418	25,032	387	930
Scotland		9,200									117		50		
Bermuda	55		15	300			130	39	27		377	1,500	291		348
British Honduras	495	100	1	28			558	543	407		313				26
Canada	143,840	75,006	1,075	14,532	15,859	1,810	201,959	97,529	5,548	5,667	551,791	28,966	126,954	25,116	34,816
Costa Rica	245						11,230	2,973	959	2,125	3,899		537		
Guatemala	1,037	2,344			1,000	176	13,000	3,048	402	2,218	1,552	12	2,732	62	
Honduras	720	42	7	200			2,201	717	85		4,798	75	409	267	
Nicaragua	640	700					1,600	387	441		599	86			71
Panama	3,746	5,924	12	144	1,454	348	8,416	3,041	2,070	1,110	9,225	2,822	17,911	326	177
Salvador	986				1,196	457	3,404	1,704	267	4,464	2,781	223	1,851	25	
Mexico	22,641	3,722	526	10,500	2,700	836	221,940	44,433	28,651	42,949	103,498	5,328	14,019	1,455	4,368
Newfoundland and Labrador	6,769	729					556	407	3,281	91	5,467	373	582		561
Barbados	147						700	211	19		139		420		94
Jamaica	1,043		2	42			759	239	757	6	3,475	32	324		365
Trinidad and Tobago	453						5,290	1,699	82		3,600	651	28	27	22
Other British West Indies	218						210	141	475		1,630		400		9
Cuba	20,919	19,742	158	4,663	2,600	582	53,206	19,857	62,567	3,226	99,704	15,220	44,086	893	13,228
Dutch West Indies	52				100	20	50	72	168		14		300		
French West Indies	227		5	124			104	19	86		318	23			
Haiti	420						95	65	96		60	47			79
Dominican Republic	369						2,894	1,235	1,124	76	1,462		446		
Argentina	12,156		40	750			16,533	4,790	40,070		23,551	16,256	1,060		1,386
Bolivia					350	162	2,888	3,424	2,346		9,827		5,581	115	420
Brazil	11,573	22,523	55	1,240	375	164	255,469	54,841	140,341	21,491	163,963	19,184	88,873	1,853	18,437
Chile	6,060				2,000	285	29,041	10,552	41,400	8	84,603	928	10,991	497	10,335
Colombia	673	884	56	965			63,547	14,468	6,032	3,378	12,311	695	1,234	38	843
Ecuador	5,987	439					19,756	5,514	1,662		1,625		2,393		679
British Guiana	728						2,724	718	630	94	1,478		106		
Dutch Guiana							474	177	156		12				
Peru	2,882	3,198			500	71	21,968	8,677	21,103	7,914	28,706	490	14,343	284	2,298
Uruguay	5,042	65					11,930	4,297	93,578	3,608	61,556	125	8,851	292	3,548
Venezuela	2,593	542			1,680	275	17,700	3,276	1,713	278	4,545	25	71	5	
China	3,484	9,526	3,548	109,768	341,183	36,317	4,539	2,048	8,451	24,089	25,048	6,856	30,570	677	12,084
Japanese China		3										396			
British India	13,050	3,756	809	23,024			26,225	8,244	122	56,300	81,393	549	36,144	7,258	1,661
Straits Settlements	225	68	38	525	2,000	240	4,320	1,462	535	66	3,614		16,445	120	9
Other British East Indies	65						4	1	109		1,086	5	135		
Dutch East Indies	10,864	800	12	64			6,350	945	78,890	6,717	11,054	2,522	6,799	1,262	
French East Indies			10	342											
Hongkong	1,742	4,199	188	4,175			2,676	1,125	34	8,179	7,011	271	1,199		238
Japan	5,856	17,048	792	12,326			300	126	2,561	568	102,089	104,639	29,242	226	3,470
Russia in Asia									813			2,234	1,800		
Siam	4,686	420					358	300	41	13,118	4,707		3,774		5,782
Australia	30,112	12,443	70	1,153	1,700	515	180,576	45,133	17,965	43,495	161,596	9,943	179,107	7,203	35,181
New Zealand	20,912	14,666			100	26	19,469	5,265		1,622	38,950	2,076	18,093	8,456	2,189
Other British Oceania	840										24				
French Oceania	846						1,400	700			180				
German Oceania	388						48	12							
Philippine Islands	10,958	7,478	527	11,759	8,000	1,663	138,874	37,095	31,954	15,046	77,067	116	16,483	4,925	3,216
British West Africa	686	620							27		895		84		
British South Africa	68,374	4,081	56	1,659			46,857	10,017	28,903	15,260	44,799	1,330	30,313	791	350
British East Africa	120										185		329		
French Africa			30	447											
Portuguese Africa	27	5,179					1,920	483		423	7,299		2,444	673	
Total	516,001	257,908	8,302	201,125	383,797	44,157	1,515,020	434,894	838,188	326,224	2,609,750	245,589	816,981	64,433	254,188

* Compiled by the Bureau of Foreign and Domestic Commerce of the Department of Commerce

Rehabilitation of the Ex-Soldier

Many of the young men who were drawn into the Army or Navy had graduated from public school or high school just a few years ago, and, like millions of others, had drifted into some blind alley where they never could advance and where they simply ground away the hours from Monday to Saturday, week in and week out, says Major Warren Bigelow, U. S. A., Director of the Re-employment Bureau of New York City for Soldiers, Sailors and Marines. The war came; they were drawn into the service; they got abroad; they even saw Paris—the great Paris; they saw the trenches; they worked and they suffered, but they have come back with more vision and a bigger outlook than they had before. They are not satisfied now to go back into the old blind alley that leads nowhere and pays the same price year after year.

But they don't know what to do. They don't know what they are fitted for besides the thing they have always done. As one man said to me, "When I had kept the books all day they were straight at night, but that is as far as I ever got." And there is the stock room clerk, the helper, the porter, the shipping clerk, who makes out bills and tags. Even if they wanted the same old job we couldn't find enough jobs for them in New York to go around.

We have to rehabilitate these men. I don't mean the wounded men; I mean the men who come back with more vision and desire to do better things than they did before. To that end we have established at this Bureau a vocational department where men who understand a bit of psychology and are skilled in the knowledge of trades, talk with a man and advise him what he can take up, what he is fitted for, and what is open to him. These men are trying to help the ex-service man realize his larger vision, the increased sense of individual power, and the better sense of proportion that he has brought back with him after facing the elemental facts of life. The employer can help us, and in doing so will in a measure repay the debt he owes to those who fought for him; he can make room for these men and can give them a fighting chance to make good and to learn a trade with a decent living wage while they are learning it.

We have taken these things up with various unions and they have expressed a desire to help us train these men. They are mostly beyond the ordinary age of apprentices, but the old system of apprenticing a man at 16 years of age has largely passed away and now with the intensive training by highly specialized methods a man can learn his trade in much shorter time than heretofore.

What we want are more opportunities for men to learn trades. We have already sent 1544 unskilled men to apprenticeships and we have induced 910 so-called clerks to change their vocation and learn a trade. This work must go on and to do it we need opportunities for men to learn things. The employer must not content himself with taking back his old employees. He must make new opportunities and send them in to us. I speak of the trades, but there are opportunities in other lines. Take a man on and teach him to be a salesman; teach him to be an executive; teach him your business and I know you will find the fighting blood will make good. All kinds went into the Army and all kinds are coming out; here and there you may have an unfortunate experience, but by and large, the men coming out are just a little better than they were when they went in.

I cannot over-emphasize the urgent need we have for learners' jobs in all trades and in all callings.

Thomas H. Cole

THOS. H COLE

Thomas H. Cole, prominent in power engineering circles, died at the Brooklyn (N. Y.) Hospital on Sunday, Aug. 24, in his fifty-second year. Mr. Cole was born in Tarryville, N. Y., and went to live in Brooklyn when a young man. His death was the result of an accident in the plant of the Benjamin Moore Paint Co., where he was employed as chief engineer for twenty-eight years. Mr. Cole was a charter member of the Brooklyn, N. A. S. E. No. 41, and was a delegate to the annual conventions for the past twenty-two years. He was also a member of Commonwealth Lodge No. 409, F. and A. M.; Long Is. Grotto No. 44; Reliance Tent No. 851, K. O. T. M. and the Order of Moose. The Masonic funeral services were conducted at his late home, 713 Decatur Street, Brooklyn, on Tuesday evening, and the interment was at Greenwood Cemetery, on Wednesday morning. Mr. Cole was highly esteemed and his absence will be felt by a host of friends. He is survived by his widow, two sons, his mother, two sisters and three brothers.

New Publications

McGraw Central Station Directory and Data Book. McGraw-Hill Co., Inc., New York. Cloth, 4¼ x 8½ in.; pages 833. Price $15.

This is the 1919 edition of this book, which is published annually. It is practically an encyclopedia of the electric-lighting industry. In the case of each company it gives the name and location, the owners or controlling interests, capitalization, bonded indebtedness, names of the officers and their addresses, details as to the number and size of the electrical and steam units in the plant, the lighting load and its rates, the cost of fuel and the territory served. The information is given in condensed form and arranged according to states, the names of the cities and towns being in alphabetical order. It thus forms a complete inventory of the central-station equipment of the country, as well as of Canada, Mexico and the West Indies. It is of great interest and value to manufacturers of power-plant equipment and electrical appliances, holding companies, financial institutions and public-service commissions.

"Boiler Safety," a new booklet just off the presses of the Travelers Indemnity Co., Hartford, Conn., is a sister booklet to "Boiler Economy," recently issued by that company. Its purpose is to describe approved ways of preventing accidents in the boiler room. It is a convenient pocket-size, and will be a handy reference book for the engineer and fireman, as well as the plant-owner. In 175 pages, the subject matter is divided up into forty sections, each of which relates to some particular phase of boiler room work, or to the care and operation of certain equipment or apparatus in the boiler room.

The first section is headed "Putting Boilers in Service," and covers all the principal operations necessary to making sure that everything is in safe and satisfactory condition for starting up. In short, it is a practical hook for practical men. Its language is clear and concise, and although it covers its ground thoroughly, there are no formulas or theoretical discussions to discourage the man with a limited education. There are also thirty-two illustrations which show the results of boiler explosions, defective parts of boilers, approved power-plant equipment, and other subjects of interest to engineers.

Engineering Affairs

The Association of Iron & Steel Electrical Engineers will hold its thirteenth annual convention at St. Louis, Sept. 22-26.

The Pennsylvania Electric Association will hold its twelfth annual convention at Bedford Springs, Penn., Sept. 3-6. Among the papers to be presented of interest to *Power* readers are the following: "The Effect of the War on Boiler-Room Practice for Medium-Sized Plants;" "Isolated Plant Costs as Influenced by the War;" "Power-Factor Correction by Means of the Static Condenser."

Personals

N. S. Braden, formerly sales manager of the Canadian Westinghouse Co., Ltd., Hamilton, Ont., has been elected vice president of the company.

Herman G. Hardy, formerly connected with the Old Hickory Powder Plant at Jacksonville, Tenn., is now chief mechanical and electrical engineer of the Arizona Copper Co., Ltd., Clifton, Ariz.

E. Caldwell has resigned as secretary of Philadelphia No. 12, N. A. S. E., after thirty-one years of service. The Association presented him wtih a beautifully engraved set of resolutions upon his retirement, and in conjunction with Vulcan Assembly gave him an outing at Fairmont Park, to which many of his friends were invited.

Captain Edward Van Winkle recently of the Engineers Corps announces his association with Frederick A. Waldron, Consulting Engineer, 37 Wall St., New York City, for the general practice of engineering with especial reference to the problems relating to the construction, development, and operation of industrials. Captain Van Winkle served 18 months in France, Belgium, Luxemburg and Germany and was in the Argonne and St. Mihiel offensives. While with the American Expeditionary Forces he was Engineer Officer of the Construction Troops which built the largest engineer depot in the advanced area, located at Issurtielle, being in charge of most of the design and of the field parties of this nineteen million project.

Business Items

The Fisher Governor Co., Marshalltown. Iowa, has opened a New York City office at 1 Franklin St., with P. L. Rhodes in charge.

The Jeffrey Manufacturing Co. Columbus, Ohio, has opened a branch office in the Book Building, Detroit, with O. B. Wescott in charge.

The Automatic Furnace Co., Dayton. Ohio, has opened a branch office at 231 Insurance Exchange Building. Chicago, with Alfred J. Saxe in charge.

The Dover Boiler Works, Dover. N. J., one of the oldest plate metal works in the East, has opened an office in the Franklin Trust Building, Philadelphia, with Henry F. Vaché in charge.

Geo. B. Allen & Co., the Texas representatives of the Vulcan Soot Cleaner Co., have removed from Houston, Texas, to Dallas, Texas, where they can be reached by mail temporarily at P. O. Box 720. Mr. Allen is a fuel economy specialist of many years experience.

The Hofmann-Sproul Co., Philadelphia. Penn., announces that the following men have joined its organization: E. R. Doud, formerly with the Tioga Steel and Iron Co., and with the Bethlehem Steel Co.; E. R. Campbell, formerly with the American Steel Foundries, and Walter Maccallum, chemical engineer.

The Chicago Pneumatic Tool Co. plans moving its general offices from Chicago to New York and toward this end is erecting a ten-story combination steel, brick and limestone office building at 6-8 East 44th St., New York City, which will be ready for occupancy early in 1920. There will be continued in Chicago a sales and service organization more extensive than formerly. The company also announces the removal of its Cincinnati office from the Mercantile Library Building to the Walsh Building, Pearl and Vine Sts., where a service station with complete stock will be maintained.

The Pierce Fuse Corp., Buffalo, N. Y., announces the following changes in its personnel: Hight & Stout will represent the company at 345 Fifth Ave., New York City; A. H. Nickerson, formerly of the Adapti Co., is the Cleveland (Ohio) representative, with offices at 310 Lenox Building; Glenn A. Wilson, formerly with the Franklin Incandescent Lamp Co., has taken over the Pierce Fuse Co.'s account in Syracuse, Rochester, Albany, Wilkesbarre, Binghamton and Batavia; R. S. Blake has been placed in charge of the new office in Chicago, at 322 Sherman St., and will take care of that territory.

Trade Catalogs

The Star Brass Works, Chicago, Ill., has just issued a twenty-four-page bulletin, No. 5, covering atomizing and spray nozzles for special applications. It deals with the application of spray nozzles for all industrial purposes, also engineering data involved in same. A copy may be had free upon request.

The B. F. Sturtevant Co., Boston, Mass., has just published a 60-page catalog, No. 256, completely describing the "Sturtevant Type 6 Steam Turbine." The catalog is divided into three parts. Part I describes the construction and general principles of this type of turbine. Part II gives instructions relating to the care and operation of the machine, and Part III shows photographs and line drawings of itemized parts to be used as reference when ordering parts.

The Joseph Dixon Crucible Co., Jersey City, N. J., has issued a new booklet, "Graphite for the Boiler," which tells in a clear and concise way how to make boiler cleaning easy. An interesting table is included in this bookelt, which shows the extra cost of coal due to the various thicknesses of scale present in boilers. The manufacturers will be glad to send a copy of this booklet, No. 94-T, to anyone who is interested.

The Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has issued a 112-page illustrated catalog No. 107, entitled "Concentration." It shows the latest types and designs of machinery that have been developed to meet the demands of modern practice. Much data covering individual machines is included which should be of value and assistance in the selection of suitable and properly balanced units for concentration work.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7 80@7 95
Stove	7 95@8.15
Chestnut	8 05@8 35

Bituminous

	Clearfields	Cambrias and Somersets
F. o. b. mines, net tons..	$2.60@3.10	$3 00@3.60
F. o. b. Philadelphia, gross tons	4 79@5.35	5.20@5.80
F. o. b. New York, gross tons	5 10@5.70	5 50@6 20
Alongside Boston (water coal), gross tons...	6 85@7.35	7.10@7 85

Georges Creek is quoted at $3 70 per net ton, f. o. b. mines.

Pocahontas and New River are being quoted at $6.25@6.60 per gross ton f.o.b. Norfolk and Newport News, Va., in response to export demand. There are practically no sales for coastwise shipment.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5 95	$7 80	Pea....	$5.20	$6.95
Egg	6 25	8 10	Buckwheat	3 40	5 15
Stove.	6.50	8.35	Rice.	2 75	4 50
Chestnut...	6 60	8.45	Barley.	2 25	4 00

Bituminous

Current quotations on spot coal, net tons, at the mines average about as follows:

	Spot
South Fork (best)	$3.25@3.50
Cambria (best)	3.00@3 25
Cambria (ordinary)	2 65@2 90
Clearfield (best)	3.00@3 25
Clearfield (ordinary)	2 70@3 00
Reynoldsville	2.70@2 90
Quemahoning	3 10@3 25
Somerset (best)	3 00@3 25
Somerset (poor)	2 65@2 75
Western Maryland	2 50@2 75
Fairmont	2.10@2 35
Latrobe	2 60@2.65
Greensburg	2 50@2.60
Westmoreland ¾ in	2.75@2 90
Westmoreland run-of-mine	2.50@2.60

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

			Anthracite		
	Line	Tide		Line	Tide
Broken....	$5.95	$7 80	Buckwheat...	$3.40	$4 45
Egg.......	6.25	8.10	Rice	2.75	3 65
Stove......	6.50	8.35	Boiler......	2.50	3 50
Nut......	6.60	8 45	Barley......	2.25	3.15
Pea........	5.20	6.80			

Illinois

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes...	$2 55@$2.75	$3 25
Mine-run	2 35@ 2 50	3 00
Screenings	1 40@ 1 60	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2 45	$2.75	$2 40
Black Creek and Cahaba	3 45	3.75	3.05
Jagger - Pratt Corona	2.85	3.05	2.45
Blacksmith	..	5.25	...

Domestic quotations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	5 00@$5.50
Corona	3 50
Jagger	3.50
Montvallo	5.50@$6.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

	Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$2.85*@3.05	$2.55	$2.25@2.50
Mine run	2 10*@2.35	2.35	1 60@1.70
Screenings	1.50*@2 20	2 05	.90@1.00

* Indicates prices on independent coal.

Williamson-Franklin rate to St Louis is $1.07½; other rates $0 92½.

New Construction

R. I., Providence—The Rhode Island Hospital, Eddy St., has had plans prepared for the construction of a 5 story, 78 x 143 ft. hospital. A steam heating system will be installed in same. Total estimated cost, $150,000. Kendall Taylor & Co., 93 Federal St., Boston, Mass., Arch.

R. I., Woonsocket—The Gold Mark Knitting Co. will soon award the contract for the construction of a 1 and 2 story, 90 x 135 ft. mill on Railroad St. Two H. P. boilers, generators and motors will be installed in same. Total estimated cost, $50,000. McClinton & Craig, 33 Lyman St., Engr.

Conn., Bridgeport—F. A. Cooper, Arch., 1024 Main St., soon receives bids for the construction of a 2 story, 65 x 214 ft. store and loft building, on Stratford Ave. and Kossuth St., for Mendelson Bros., 622 Water St. Electric power equipment and steam heating system will be installed in same. Total estimated cost, $60,000.

N. Y., New York (Bronx)—The Bronx Consumers' Ice Co., DeVoe Ave. and 180th St., is having plans prepared for altering its 2 story, 146 x 155 ft. ice plant. Total estimated cost, $60,000. Max Hansle, 3307 3rd Ave., Engr. and Arch.

N. Y., Brooklyn—The Board of Education, 500 Park Ave., New York City, is having plans prepared for the construction of a 4 story school on Howard Ave. and Prospect Pl. A steam heating system will be installed in same. Total estimated cost, $200,000. C. B. J. Snyder, Municipal Bldg., New York City, Engr. and Arch.

N. Y., Brooklyn—The Congregation Tiefereth Israel, c/o Shampan & Shampan, Arch., 50 Court St., is having plans prepared for the construction of a 2 story synagogue on 14th St. near 7th Ave. A steam heating system will be installed in same. Total estimated cost, $250,000.

N. Y., Brooklyn—A. A. Schwartz, 815 Flatbush Ave., will build a 1 story, 175 x 175 ft. theatre on Fulton St. and New York Ave. A steam heating system will be installed in same. Total estimated cost, $500,000. Work will be done by day labor.

N. Y., Brooklyn—Slee & Bryson, Engr. and Arch., 154 Montague St., will receive bids September 22, for the construction of a 3 story, 65 x 90 ft. office building, on Jay St. and Willoughby Ave., for the Home Title Insurance Co., Jay and Pearl St. A steam heating system will be installed in same. Total estimated cost, $100,000.

N. Y., Jamaica—The Long Island Motion Pictures Co. will build a 135 x 140 ft. theatre on Fulton St. A steam heating system will be installed in same. Total estimated cost, $250,000. Work will be done by day labor.

N. Y., Jamaica—The St. Mary's Hospital, Shelton Ave., is having plans prepared for the construction of a 5 story, 100 x 150 ft. addition to hospital. A steam heating system will be installed in same. Total estimated cost, $250,000. F. J. Berlinbach, 260 Graham Ave., Brooklyn, Engr. and Arch.

N. Y., Kings Park—The State Hospital Commission, Capitol, Albany, will receive bids until September 10, for construction. heating, sanitary and electric work of building for Acute Patients, at Kings Park State Hospital, here.

N. Y., Long Island City—Board of Education, 500 Park Ave., New York City, is having plans prepared for the construction of a 4 story school on Curtis Ave., between Broadway and Belmont Ave. A steam heating system will be installed in same. Total estimated cost, $200,000. C. B. J. Snyder, Municipal Bldg., New York City, Engr. and Arch.

N. Y., New York—The Board of Education is having plans prepared for the construction of a 5 story addition to school at 205 East 109th St. A steam heating system will be installed in same. Total estimated cost, $200,000. C. B. J. Snyder, Municipal Bldg., Engr. and Arch.

N. Y., New York—Buchman & Kahn, Engr. and Arch., 56 West 45th St., will receive bids September 15, for the construction of a 6 story, 75 x 200 ft. addition to factory, on Ave. D between 13th and 14th St., for the Eagle Pencil Co., 703 East 13th St. A steam heating system will be installed in same.

N. Y., New York—R. G. Cory, Arch. and Engr., 39 Cortland St., will receive bids about September 10, for the construction of a 6 story, 75 x 150 ft. factory, for the

C. Cory Co., 290 Hudson St. A steam heating system will be installed in same. Total estimated cost, $200,000.

N. Y., Rochester—The Polish Clothing Manufacturing Co., Inc., plans the construction of a 3 story, 75 x 75 ft. factory on Hudson Ave. and Avenue D. Steam heating plant, electric power and transmission will be installed in same. Total estimated cost between $60,000 and $75,000. Adam Norwich, Pres.

N. Y., Troy—Franklin W. Ward, Secy., State Board of Armory Commissioners, 158 State St., Albany, will receive bids until September 4 for building, heating, sanitary and electric work, for State Armory here.

Md., Annapolis—The Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to build a power house, and install 3 boilers here. Total estimated cost, $130,000.

Md., Baltimore—R. L. Harris, Arch., 2027 Kennedy Ave., is receiving bids for the construction of a 2 story, 60 x 90 ft. ice storage plant, for the Crystal Ice Co., Chester St. and North Ave. Total estimated cost, $70,000.

D. C., Washington—Spec. No. 3708—The Bureau of Yards and Docks, Navy Department, soon receives bids for installing mechanical equipment and piping for boiler shop, here. Estimated cost, $200,000.

Va., Hampton Roads—The Bureau of Yards and Docks, Navy Department, Washington, D. C, plans to build an engine house, blacksmith, plumbing and machine shop, here. Total estimated cost, $160,000.

W. Va., Riverside—The Monongahela Valley Traction Co., Fairmont, plans to double the capacity of its power plant here, and extend high tension lines to Meriden, Gratton and Riverside, also install two 10,000-kw. turbines. Estimated cost, $1,000,000. G. M. Alexander, Fairmont, Ch. Engr.

N. C., Ronda—The Ronda Cotton Mills, Inc., is in the market for power plant equipment for the proposed 1 story, 80 x 300 ft. cotton mill which it plans to build. Total estimated cost, $250,000.

N. C., Wendell—The city will receive bids September 11, for a deep well and pump in connection with proposed waterworks and sewerage systems. Total estimated cost, $30,000. Gilbert White, Durham, Engr.

S. C., Charleston—The Bureau of Yards and Docks, Navy Department, Washington, D. C., will receive bids September 10, for the installation of mechanical stokers in central power plant here. Estimated cost, $11,000.

Ohio, Ansonia—G. L. McKibben, consult. engr., Vannert, will receive bids about September 10 for the installation of a water and light plant for the village.

Ohio, Cleveland—The Martin Barriss Co., 2048 West 3rd St., plans to construct a 2 story, 36 x 165 ft. saw mill and power house. A steam heating system will be installed in same. Total estimated cost, $100,000. Architect not selected.

Ohio, Cleveland—The Cleveland Plain Dealer Co., East 6th St. and Superior Ave., plans to build a 6 story, 40 x 198 ft. addition to publishing house. A steam heating system will be installed in same. Total estimated cost, $250,000.

Ohio, Cleveland—M. J. Hinkle, Huron Rd. and East 9th St., plans to build a 2 story, 125 x 140 ft. sales and service building on East 67th and Carnegie Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—H. P. McIntosh, Euclid Ave., plans to build a 3 story, 70 x 135 ft. addition to office, on Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $150,000.

Mich., Detroit—Frank M. Pauli Co., 30 Shipherd Ave., plans to erect a 2 story, 30 x 80 ft. mill work factory, on Six Mile Rd along the Grand Trunk Railroad. Electric motors to supply power will be installed in same. Total estimated cost, $13,000. Work will be done by day labor.

Mich., Detroit—Young Bros., 213 Franklin St., are receiving bids for the construction of a 1 and 2 story, 105 x 161 ft. factory, on Beufait Ave. Steam boiler and equipment, and electric motor for power, will be installed. C. W. Brandt, 1114 Kresge Bldg., Arch.

Mich., Lansing—The Hall Lumber Co., Michigan Ave. and Larch St., plans to construct a 2 story, 50 x 200 ft. millwork factory, on North Larch St. Electric motors for power will be installed in same.

Mich., Marysville—The Detroit Edison Co., David Whitney Bldg., Detroit, plans to construct an electric steam power plant to contain 30,000 kw. unit, along St. Clair River and Bunce Creek.

Mich., St. Louis—M. E. Hull, Secy., of the Board of Education will receive bids September 1, for the construction of a 2 story addition to the present Union school building, District No. 1. A steam heating plant, consisting of boiler, pump and fan, to be bid upon separately. Total estimated cost, $50,000. Cowles & Mutscheller, Chase Bldg., Saginaw, Arch.

Ill., Chicago—The Gramm-Bernstein Motor Truck Co., East Wayne and Scott St., Lima, Ohio, plans to construct a 2 story, 70 x 190 ft. sales and service building at 2439 Wabash Ave. A steam heating system will be installed in same. Total estimated cost, $150,000.

Ill., Chicago—Alexander L. Levy, Arch., 111 West Washington St., is receiving bids for a 3 story, 90 x 150 ft. theatre, at 2040 West Division St., for Reingold & Auerkach, 856 North Clark St. A steam heating system will be installed in same. Total estimated cost, $250,000.

Ill., Chicago—Marshall & Fox, Arch., 721 North Michigan Ave., are receiving bids for the construction of a 3 story, 100 x 150 ft. auto service station, on Indiana Ave. and 23rd St., for the Cadillac Automobile Co., 2301 South Michigan Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ill., Chicago—Moores & Dunford, Eng., 38 South Dearborn St., are receiving bids for the construction of a 6 story, 50 x 120 ft. storage building, at 6345 Broadway, for Sidney & David. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ill., Chicago—The A. W. Shaw Co., 5 North Wabash Ave., is having plans prepared for the construction of a 2 story, 120 x 210 ft. office building, on Cass and Erie St. A steam heating system will be installed in same. D. H. Burnham & Co., 209 South LaSalle St., Arch.

Wis., Janesville—The Samson Tractor Plant is having plans prepared for a new heating plant here. The first unit of this plant will have a capacity of 2000 hp., and will be equipped with Sterling boilers and Taylor stokers. Frank D. Chase, 645 North Michigan Ave., Chicago, Ill., Engr.

Wis., Kiel—The Kiel Furniture Co. plans to build a 2 story, 40 x 160 ft. furniture building, on Main St. A steam heating system, and 2 new 5½ x 16 ft. boilers will be installed in same. Total estimated cost, $25,000.

Minn., Mountain Lake—The village is in the market for a motor driven double stroke well pump. H. C. Hanson, Clk.

N. D., Fort Yates—The Department of the Interior, Office of Indian Affairs, Washington, D. C., is receiving bids for the installation of an electric lighting plant here.

Mo., St. Louis—H. J. Wise, Engr., Post-Dispatch Bldg., will soon receive bids for the construction of a 2 story, 90 x 252 ft. addition to laundry, at 1745 South 18th St., for A. J. Feuerbacher, c/o Superior Laundry Co. Boilers will be installed in same. Total estimated cost, $80,000.

Mo., Sugar Creek—The Board of Education will soon award contract for the construction of a 2 story, 63 x 86 ft. school and 1 story, 24 x 50 ft. boiler house. A steam heating plant will be installed in same. Total estimated cost, $65,000. A. B. Anderson, 818 New York Life Bldg., Kansas City, Arch.

Texas, Fort Worth—H. H. Morrison, Engr., Fullerton Bldg., St. Louis, Mo., will soon receive bids for the construction of a 17 story, 108 x 200 ft. and 10 x 220 ft. hotel here, on 8th and Commerce St., for the Winfield Hotel Co. A steam heating system will be installed in same. Total estimated cost, $1,000,000.

Okla., Hobart—The city plans an election soon to vote on $135,000 bonds for the construction of an electric light plant. J. J. Hunt, Mayor. V. V. Long & Co., Oklahoma, Engr.

Okla., Holdenville—Hughes County is receiving bids for the construction of a 3 story, 88 x 96 ft. court house and jail. A steam heating sytem will be installed in same. Total estimated cost, $125,000. Layton, Smith & Forsyth, 701 May Bldg., Oklahoma, Arch.

Okla., Oklahoma City—First Church of Christ, Scientist, is receiving bids for building a 2 story, 90 x 100 ft. church. A steam heating system will be installed in same. Total estimated cost, $100,000. C. L. Butler, Tulsa, Arch.

Utah, Monti—The city has retained F. G. McGonagle, Engr., Salt Lake City, to prepare plans for an electric light plant. Total estimated cost, $25,000. Noted Jan. 7.

Ariz., Phoenix—The Union Oil Co. of Arizona, 15th and Santa Fe St. will build a plant, to consist of a warehouse, office, pump house, garage, storage tanks, etc. Total estimated cost, $100,000. Union Oil Co. of California, Union Oil Bldg., Los Angeles, Engr. Work will be done by day labor.

Ariz., Roosevelt—The Salt River Valley Water Users' Association, Phoenix, plans to construct a 5000 kw. steam generating plant for furnishing power to about 60 pumps which will be used to lower underground water level. Pumps are now being installed. C. A. Vander Veer, secy.

Ariz., Tempe—The Water Users' Association of Phoenix plan to construct a 5000 kw. steam generating plant at the Crosscut Canal, near here, to supplement the hydro-electric plant at Roosevelt. Total estimated cost, about $500,000.

Wash., Puget Sound (Bremerton P. O.)—Spec. No. 3837—The Bureau Yards & Docks, Navy Dept., Washington, D. C., plans to construct a reciprocating air compressor here. Estimated cost, $62,000.

Ore., Astoria—The Astoria Apartment Co. will soon award the contract for the construction of a 3 story, 60 x 200 ft. apartment hotel here. A vapor steam heating plant will be installed in same. G. M. McBride, Yeon Bldg., Portland, Pres. F. M. White, Chamber of Commerce Bldg., Porland, Arch.

Cal., Arcadia—The city voted $150,000 bonds to construct a 1,000,000 gallon reservoir and a smaller reservoir, sink a well, lay about 15 miles of pipe line and install 2 booster pumps and 1 pump at well. H. S. Gierlich, City Engr.

Cal., Grass Valley—The Grass Valley Bullion Exploration Co. plans to construct a quartz mine and is in the market for electrical hoist and pumps. Total estimated cost, $300,000. G. E. Mainhart, Supt.

Cal., Huntington Beach—The property owners on the Huntington Beach, Meca, are organizing an irrigation district to construct small dams in Santa Anna River, install pumps to lift water 75 ft. and construct pipe lines to irrigate about 2500 acres. G. F. Fowler, A. G. Thornton and J. Vaura comprise committee in charge.

Cal., Los Angeles—The Board of Public Service Commissioners will drill one hundred 8 and 12 in. wells in the Owens River Valley, Inyo County, to augment supply to the Los Angeles acqueduct. Pumps and pipe lines will probably be installed.

Cal., Los Angeles—The Board of Public Service Commissioners has filed claims for locations for city power plants on South Fork of Kern River. Total estimated cost, $10,000,000. E. F. Scattergood, 645 South Olive St., Engr.

Cal., Mare Island—Spec. 3982—The Bureau of Yards & Docks, Navy Dpartment, Washington, D. C., will soon award the contract for electric lighting and power systems, here. Estimated cost, $25,000.

Cal., Mare Island—Spec. 4018—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to install a 4000 kw. turbo-generator, here. Estimated cost, $45,000.

Que., Montreal—The Allen Theatre Enterprises, Richmond St., E., Toronto, Ont., are having plans prepared, for a 2 story, 45 x 70 ft. theatre on McGill St., here. Steam boilers and equipment will be installed in same. Total estimated cost, $250,000. C. H. Crane and E. G. Kiehler, 2325 Dime Bank Bldg., Detroit, Mich., Arch.

Ont., Birch Cliff—Scarboro Township plans to install electrically driven centrifugal pumps in connection with proposed waterworks system. Total estimated cost, $100,000. E. James, 57 Adelaide St., East Toronto, Engr.

Ont., Chatham—The city plans to install a new waterworks system. Plans include intake, pumphouse and 5,000,000 gallon reservoir. Total estimated cost, $200,000. James, Landon & Hertzberg, Ltd., 36 Toronto St., Toronto, Engr.

Ont., Forest—The town council plans to contruct a new waterworks system. Electrically driven pumping equipment will be installed. James, Landon & Hertzberg, Excelsior Life Bldg., Toronto, Engr.

Ont., Hamilton—The Board of Education will recive bids until September 9 for the construction of a 2 story school on Hunter St., W. A steam heating system, electric motor and fan will be installed in same. Total estiamted cost, $125,000. F. W. Warren, Bank of Hamilton Bldg., Engr. and Arch.

Ont., Oshawa — The Gananoque Spring & Axle Co. will build a 1 story, 80 x 200 ft. factory and office building. A hot air system of heating will be installed. Total estimated cost, $100,000. Work will be done by day labor.

Ont., St. Catharines—The Public School Board will soon award the contract for the construction of two 2 story, 8 room, schools. Steam heating systems will be installed in same. Total estimated cost, $140,000. A. E. Nicholson, 46 Queen St., Arch.

CONTRACTS AWARDED

Mass., Attleboro—The Board of Education has awarded the contract for the construction of a 2 story, 57 x 106 ft. addition to Bliss school, to Everett O. Dexter, Attleboro. A steam heating system will be installed in same. Total estimated cost, $100,000.

Conn., Bridgeport—The Bryant Electric Co., 1421 State St., has awarded the contract for the construction of a 4 story, 60 x 220 ft. factory on Hancock Ave., to William Martin & Sons, 164 State St. Electric power and steam heating system will be installed in same. Total estimated cost, $90,000.

Conn., Hartford—The Connecticut General Life Insurance Co., 64 Pearl St., has awarded the contract for the construction of a 5 and 6 story office building, on Elm St., to Marc Eidlitz, 30 East 42nd St., New York City. A steam heating system will be installed in same.

Conn., Hartford—The Hartford Electric Light Co., 226 Pearl St., has awarded the contract for the construction of a power plant, on Colt's Meadows, to Stone & Webster, 147 Milk St., Boston, Mass. Total estimated cost, $1,000,000.

Conn., Hartford—The Hartford Fire Insurance Co., 125 Trumbull St., has awarded the contract for the construction of an office building on Farmington Ave., to Marc Eidlitz & Sons Co., 30 East 42nd St., New York City. A steam heating system will be installed in same. Total estimated cost, $1,000,000.

Conn., Shelton—Sidney Blumenthal & Co., 37 Canal St., has awarded the contract for the construction of a 4 story, 50 x 120 ft. factory, and a 1 story, 40 x 180 ft shed, on Canal St., to the Thompson & Binger Co., 280 Madison Ave., New York City. Electric power and steam heating system will be installed in same. Total estimated cost, $70,000.

N. Y., Brooklyn—J. W. Masury & Son, 50 Jay St., has awarded the contract for the construction of a 6 story, 50 x 105 ft. factory building, on Plymouth and Jay St., to the Turner Construction Co., 244 Madison Ave., New York City. A steam heating system will be installed in same.

N. Y., Brooklyn—The Young Men's Christian Association, 1181 Bedford Ave., has awarded the contract for the construction of a 3 story, 75 x 100 ft. engineering school, on Bedford Ave. and Monroe St., to the Wills-Egeloff Co., 101 Park Ave., New York City. A steam heating system will be installed in same.

N. Y., Elmhorst—The Mispah Lodge, F. & A. M., has awarded the contract for the construction of a 2 story, 50 x 100 ft. temple, on Whitney Ave., to J. C. Woodruff, 1 Bridge Plaza, Long Island City. A steam heating system will be installed in same. Total estimated cost, $130,000.

N. Y., Long Island City—The Long Island City Savings Bank has awarded the contract for the construction of a 4 story, 70 x 80 x 100 ft. bank on Hunter Ave. and Academy Pl., to the Gillie-Campbell Co., 101 Park Ave., New York City. A steam heating system will be installed in same.

N. Y., Long Island City—The Wappler Electric Co., Harris Ave., has awarded the contract for the construction of a 2 story, 175 x 255 ft. factory, on Van Alst and Harris Ave., to the Turner Construction Co., 244 Madison Ave., New York City. A steam heating system will be installed in same.

N. Y., New York—The American Radiator Co., 104 West 42nd St., has awarded the contract for the construction of a 2 story, 115 x 185 ft. factory and warehouse, on Exterior and 149th St., to Post & McCord, 101 Park Ave. A steam heating system will be installed in same. Total estimated cost, $120,000.

N. Y., New York—The National Biscuit Co., 409 West 15th St., has awarded the contract for the construction of a 2 story, 124 x 161 ft. bakery, at 469-485 Bethune St., to Isaac Beers, 162 East 23rd St. A steam heating system will be installed in same. Total estimated cost, $125,000.

N. Y., New York—The New York Edison Co., Irving Pl. and 15th St., has awarded the contract for the construction of a 3 story, 55 x 75 ft. office and power house, at 31 Hester St., to the George Sykes Co., 70 East 45th St. A steam heating system will be installed in same.

N. Y., New York—The 110 West 55th St. Incorporation, 19 West 44th St., has awarded the contract for the construction of a 15 story hotel, at 110-120 West 55th St., to Fred T. Ley, 19 West 44th St. A steam heating system will be installed in same. Total estimated cost, $560,000.

N. Y., Syracuse—The Board of Contracts and Supplies has awarded the contract for installing heating and ventilating systems in the Frazer School, 741 Park Ave., to W. B. Goldie, 274 James St. Estimated cost, $14,876.

N. J., Newark—The Coacoanut Oil Co. has awarded the contract for the construction of a group of 2 and 3 story factories, to J. Lowery, Jr., 108 West 40th St., New York City. Steam heating systems will be installed in same. Total estimated cost, $150,000.

Pa., Philadelphia—The Hood Manufacturing Co., 19th and Westmoreland Aves., has awarded the contract for the construction of a 3 story, 80 x 140 ft. factory, to W. Steele & Sons, 16th and Arch St. A steam heating system will be installed in same. Total estimated cost, $120,000.

Penn., Philadelphia—The St. John's Home, 49th and Wyalusing Sts., has awarded the contract for the construction of 3 story school and dormitory buildings, to P. J. and J. T. Whelan, Lincoln Bldg. Steam heating systems will be installed in same.

Penn., Philadelphia—The A. Schoenhut Co., Adams and Seprivo St., has awarded the contract for the construction of a 2 story, 50 x 130 ft. factory and boiler house, on Amber and Venango St., to Philip Haibach, 1261 North 26th St.

Md., Baltimore—McCormick & Co., Pratt St. and Market Pl., has awarded the contract for the construction of an 8 story, 240 x 320 ft. warehouse on Light, Barre and Charles St., to M. A. Long & Co., Charles and Baltimore St. A 200 hp. boiler, 2 passenger and 4 freight elevators will be installed in same. Total estimated cost, $1,250,000.

N. C., Warsaw—The city has awarded the contract for deep well pumps, in connection with proposed waterworks system, to the Sydnor Pump & Well Co., 302 East Main St., Richmond, Va., $2290, boilers, to Schofield Sons Co., Hammond and Boundary St., Macon, Ga., $2900. Noted July 22.

Ohio, Cleveland—The National Lamp Works, Nela Park, has awarded the contract for the construction of a 2 story, 64 x 139 ft. service building, to Crowell, Lundoff, Little Co., Meriam Bldg. A steam heating system will be installed in same. Total estimated cost, $150,000. Noted August 19.

Ohio, Cleveland Heights—The Board of Education has awarded the contract for the construction of a 3 story, 125 x 200 ft. school, on Lee Rd., to the Phillip Kirschner Co., 1008 Hippodrome Bldg., Cleveland. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ohio, East Canton — The Pennsylvania Lines West of Pittsburgh, Penobscot Bldg., Detroit, Mich., has awarded the contract for the construction of a 1 story, 90 x 300 ft. oil tank shop, at railway terminal here. A steam heating plant, consisting of boiler and accessories, will be installed in same.

Ohio, Washington—The Sunlight Creamery Co., c/o Cudahy Package Co., 111 West Monroe St., Chicago, has awarded the contract for the construction of a 1½ story, 60 x 235 ft. creamery here, to the W. Adams Co., 209 South La Salle St., Chicago. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ill., Cairo—The Bureau of Yards and Docks, Navy Department, Washington, D. C., has awarded the contract for new motor driven triplex pump, etc., to be installed in Post Office here, to J. J. O'Shea, 1203 Washington Ave. Estimated cost, $3250.

Ill., Chicago—The Cook County Paper Stock Co., 2325 LaSalle St., has awarded the contract for the construction of a 1 story, 600 x 1100 ft. warehouse, 1 story, 300 x 950 ft. factory, 3 story, 100 x 120 ft., and 1 story, 100 x 300 ft. heavy storage warehouse, and 1 story, 60 x 200 ft. garage and repair shop, on 31st St. and Kedzie Ave., to the Shank Co., 30 North LaSalle St. Steam power and heating systems will be installed in same. Total estimated cost, $1,000,000.

Ill., Peoria—The National Warehouse Co. has awarded the contract for the construction of a 7 story, 80 x 140 ft. warehouse, on Cedar and Washington St., to F. B. Hasbrouck, 325 Ellis St. A steam heating system will be installed in same. Total estimated cost, $200,000.

Wis., Port Washington—The city has awarded the contract for the construction of a 1 story, 40 x 180 ft. power plant on Main St., to Joseph Ubbink, Main St. Total estimated cost, $50,000.

Wis., Two Rivers—The Hamilton Manufacturing Co. has awarded the contract for the construction of a 2 story, 40 x 150 ft. power house on Main St., to W. W. Oeflein, 86 Michigan St., Milwaukee. Total estimated cost, $50,000.

Neb., Fall City—The city has awarded the contract for the construction of a 1 story power plant, to the Merkle Machinery Co., 508 Interstate Bldg., Kansas City, Mo. Total estimated cost, $43,100. Noted July 8.

Neb., Omaha—The Skinner Packing Co., 904 1st National Bank Bldg., has awarded the contract for the construction of an 8 story, 99 x 132 ft. cold storage plant, on 12th and Douglas St., to the G. W. Stiles Construction Co., 1218 1st National Bank Bldg. Total estimated cost, $500,000. Noted April 29.

Mo., St. Louis—The Ely & Walker Dry Goods Co., 16th St. and Washington Ave., has awarded the contract for the construction of an addition to its warehouse at 1519 Locust St., and 1510-18 St. Charles St., to James Stewart & Co., Inc., Boatmen's Bank Bldg. A steam heating system will be installed in same. Total estimated cost, $300,000.

Mo., St. Louis—The International Fur Exchange (Funsten Bros. Co.), 2nd and Market St., has awarded the contract for the construction of a 7 story storage house, on 4th and Market St., to J. A. Godfrey & Co., Wainwright Bldg. Elevators will be installed in same. Total estimated cost, $500,000.

Ariz., Phoenix—Dwight B. Heard, Central and Adams St., has awarded the contract for the construction of a 4 story, 70 x 148 ft. office building, to J. W. Martin, Phoenix. A steam heating system will be installed in same. Total estimated cost, $250,000

Other Opportunities—

will be found on pages 143 to 153.

It is the "Opportunity" section of this paper. Examine it regularly. Whenever you have a business want—to locate or offer employment equipment or business opportunities, *ALWAYS*

"Think SEARCHLIGHT First"

PRICES-MATERIALS-SUPPLIES

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE—

Fire	50-Ft. Lengths
Underwriters' 2½-in	75c. per ft.
Common, 2½-in	40%

Air	First Grade	Second Grade	Third Grade
¾-in. per ft	$0 50	$0 33	$0 22

Steam—Discounts from List

First grade . . . 30% Second grade . . . . . 40% Third grade . . . 45%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	65%	Best grade	35%
Standard	50%		

Note—Above discounts apply on new list issued July 1.

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	45%	35%
St. Louis	40%	30%
Chicago	45%	40%
Birmingham	35%	30%
Denver	35–5%	30%

RAWHIDE LACING—20% for cut; 45c. per sq. ft. for ordinary.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0 90
Asbestos for high-pressure steam	1 50
Duck and rubber for piston packing	1 00
Flax, regular	1 20
Flax, waterproofed	1 60
Compressed asbestos sheet	90
Wire insertion asbestos sheet	1 10
Rubber sheet	.50
Rubber sheet, wire insertion	70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1 20
Asbestos wick, ½- and 1-lb. balls	85

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	60	2 -in.	.60
3-in.	45	2½-in.	.75
8-in.	1 10	3 -in.	.90
10-in.	1.30	3½-in.	1 05

85% magnesia high pressure		List
For low-pressure heating and return lines	4-ply	58% off
	3-ply	60% off
	2-ply	62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Pittsburgh	Chicago	St. Louis	Birmingham	Denver
Cup	7	9	5¼	6.7	8½	14½
Fiber or sponge	8	10	6	13	9	18
Transmission	7	9	6	13	7½	17
Axle	4½	6	4	4 75	3–4	5¼
Gear	4½	9	4½	7.5	5½	8
Car journal	22(gal.)	21 (gal.)	3½	4 7	6¾	8

COTTON WASTE—The following prices are in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Whites	13.00	11 00 to 13 00	14 00	11 00 to 14 00
Colored mixed	9.00 to 12.00	8.50 to 12 00	11 00	9 50 to 12 00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13½ x 13½	13¾ x 20½
Cleveland	$52 00	$58 00
Chicago	41 00	43 50

LINSEED OIL—These prices are per gallon:

	New York		Cleveland	Chicago	
	Current	One Year Ago	Current	Current	One Year Ago
Raw in barrels (5 bbl. lots)	$2.15	$1 86	$2 50	$2.48	$1 97
5-gal. cans	2.28	1.96	2.75	2.68	2.17

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	13 00	14 50	14 00	14 50	13 00	14 00
25- and 50-lb. kegs	13 25	14.75	14 25	12 75	13 25	14 25
12½-lb. keg	13 50	15 00	14 50	15 00	13 50	14 50
1-lb. cans	16 00	17.50	....	....	16 00	17 00
5-lb. cans	15 00	16.50	....	....	15 00	16 00

500 lb. lots less 10% discount; 2000 lb. lots less 10–2½%.

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel 7/16 and smaller	50–10%	60%	55%
Tinned	50–10%	60%	55%

Boiler rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York. . $4 72 Cleveland. . $4.00 Chicago. . $4.87 Pittsburgh...$4 20

Structual rivets, same sizes:

New York. . . $4 82 Cleveland. . $4.10 Chicago. . . $4.97 Pittsburgh...$4.30

REFRACTORIES—Following prices are f. o. b. works, Pittsburgh:

Chrome brick	net ton	$80–90	at Chester, Penn.
Chrome cement	net ton	45–50	at Chester, Penn.
Clay brick, 1st quality fireclay	net ton	35-45	at Clearfield, Penn.
Clay brick, 2nd quality	net ton	30-35	at Clearfield, Penn.
Magnesite, dead burned	net ton	32 50	at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in	net ton	80-90	at Chester, Penn.
Silica brick	net ton	41–45	at Mt. Union, Penn.

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—Fire Clay, $35 to $50.
Birmingham—Silica, $48; fire clay, $42; magnesite, $85; chrome, $85.
Chicago—Second quality, $25 per ton.
Denver—Fire clay, $11 per ton.

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	90 00	125 00	80 00	108 00	60 00	100 00
Commercial	50 00	70 00	18 50	23 00	13 00	24 00

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$21–26	$19 00
Cleveland	20 00	20 00
Chicago	16.50	19 00

In coils an advance of 50c. usually is charged.
Domestic iron (Swedish analysis) is selling at 15c. per lb.

POLES—Prices on Western red cedar poles:

	New York	Chicago	Denver	San Francisco
6 in. by 30 ft	$5 82	$5.17	$4.55	$5.17
7 in. by 30 ft	7 65	6 85	6.10	6 85
7 in. by 35 ft	11 10	10 00	8.95	10 00
8 in. by 35 ft	12 65	11 35	10.10	11 35
7 in. by 40 ft	12 85	11.50	10.20	11 50
8 in. by 45 ft	18 90	16.90	15.00	16 90
8 in. by 50 ft	22.65	20 30	18 00	20 30

10c. higher freight rates on account of double loads
For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft	$9 00
12-in. butts, 6-in. tops, length 30-40 ft	11 50
12-in. butts, 6-in. tops, length 41-50 ft	12 50
14-in. butts, 6-in. tops, length 51-60 ft	21 00
14-in. butts, 6-in. tops, length 61-71 ft	23 50

PIPE—The following discounts are for carload lots f. o. b. Pittsburgh; basing card of Jan. 1, 1919, for steel pipe and for iron pipe:

BUTT WELD

	Steel			Iron	
Inches	Black	Galvanized	Inches	Black	Galvanized
⅛, ¼, and ⅜	50½%	24%	¾ to 1½	39½%	23½%
½	54½%	40%			
¾ to 3	57½%	44%			

LAP WELD

2	50½%	38%	2	32½%	18½%
2½ to 6	53½%	41%	2½ to 6	34½%	21½%

BUTT WELD, EXTRA STRONG PLAIN ENDS

⅛, ¼ and ⅜	46½%	29%	¾ to 1½	39½%	24½%
½	51½%	39%			
¾ to 1½	55½%	43%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	48%	37½%	2	33½%	20½%
2½ to 4	51%	40½%	2½ to 4	35½%	23½%
4½ to 6	50%	39½%	4½ to 6	34½%	22½%

Stock discounts in cities named are as follows:

	New York		Cleveland		Chicago	
	Black	Galvanized	Black	Galvanized	Black	Galvanized
¾ to 3 in. steel butt welded	47%	31%	43½%	34½%	57½%	44%
1½ to 3 in. steel lap welded	42%	27%	45½%	30½%	53½%	41%

Malleable fittings. Class B and C, from New York stock sell at list + 12½%.
Cast iron, standard sizes, 10–5% off

BOILER TUBES—The following are the prices for carload lots, f o. b. Pittsburgh:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in	40½	3½ to 4½ in	15½
2½ to 3¼ in	30½	3 to 3¼ in	1
2¼ in	24	2½ to 2¾ in	+ 1
1¾ to 2 in	19½	2 to 2¼ in	+16
		1¾ to 1⅞ in	+29

Standard Commercial Seamless—Cold Drawn or Hot Rolled

	Per Net Ton		Per Net Ton
1 in	$327	1¾ in	$207
1¼ in	267	2 to 2¼ in	177
1⅜ in	257	2½ to 3¼ in	167
1½ in	207	4 in	187
		4½ to 5 in	207

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation.

ELECTRICAL SUPPLIES

ARMORED CABLE—

B.&S Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$104 00	$138 00	$164 00	$210.00
No. 12 solid	135 00	170.00	225 00	265.00
No. 10 solid	185 00	235 00	275 00	325 00
No. 8 stranded	285 00	375 00	520 00	500 00
No. 6 stranded	400 00	500 00	560 00	

From the above lists discounts are:

Less than coil lots	Net List
Coils to 1,000 ft	10%
1,000 ft. and over	15%

BATTERIES. DRY—Regular No. 6 size red seal, Columbia, or Ever Ready

	Each, Net
Less than 12	$0 40
12 to 50	38
50 to 125 (bbl.)	35
125 (bbl.) or over	.32

CONDUITS. ELBOWS AND COUPLINGS—Following are warehousee net prices per 1000 ft. for conduit and per 100 for couplings and elbows:

	Conduit		Elbows		Couplings	
Size, In.	Black 1,000 Ft. and Over	Galvanized 1,000 Ft. and Over	Black 100 and Over	Galvanized 100 and Over	Black 100 and Over	Gavanized 1100 and Over
⅜	$71 15	$76.25	$17 04	$18 18	$5 38	$5.74
½	71 15	76 25	17 04	18.18	6 28	6.70
¾	93.96	100 86	22 43	23.93	8 97	9.57
1	138 39	149.09	33 19	35 41	11 66	12.44
1¼	187 91	201 71	42 62	45.31	16.10	17 12
1½	224 68	241 18	56.82	60 62	19 89	21 15
2	302 29	324.49	104 17	110 77	26.52	28.20
2½	477 95	513.05	170.46	181 26	37 88	40.28
3	625.00	670.91	454 56	483 36	56 82	60.42
3½	779 24	834 44	1,003.82	1,067.42	75.76	80.56
4	945.03	1,010.43	1,160.08	1,233.57	94 70	100.70

5% cash 10 days.

From New York Warehouse—Less 5% cash.

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

CONDUIT NON-METALLIC. LOOM—

Size I. D., In.	Feet per Coil	List, Ft.
[illegible]	250	$0.05½
¼	250	.06
⅜	250	09
½	200	.12
⅝	200	15
¾	150	.18
1	100	25
1¼	100	.33
1½	Odd lengths	40
2	Odd lengths	.55

Coils. 55% off
Less coils. 45% off

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L	$0 11	T. P. to D. P. S. B	$0 24
D. P. M. L	18	T. P. to D. P. T. B	38
T. P. M. L.	26	T. P. S. B	33
D. P. S. B	.19	T. P. D. B	.54
D. P. D. B	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L	$0 33	$0 84	$1 68
T. P. M. L	48	1 20	2 40
D. P. S. B	42	1 05	
T. P. S. B	81	1 80	
D. P. D. B.	78	2 10	
T. P. D. B	1 35	3 60	
T. P. to D. P. D. B	90	2.52	

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.

No. 18 cotton twisted	$16 75
No. 16 cotton twisted	22 00
No. 18 cotton parallel	19 80
No. 16 cotton parallel	25 75
No. 18 cotton reinforced heavy	30 00
No. 16 cotton reinforced heavy	36.50
No. 18 cotton reinforced light	23 40
No. 16 cotton reinforced light	27 50
No. 18 cotton Canvasite cord	26.00
No. 16 cotton Canvasite cord	28.50

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List
3-amp. to 30-amp	100	$0 25
35-amp. to 60-amp	100	35
65-amp. to 100-amp.	50	90
10-amp. to 200-amp	25	2.00
25-amp. to 400-amp	25	3 60
[illegible]-amp to 600-amp	10	5 50

600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	.40
35-amp. to 60-amp.	100	.60
65-amp. to 100-amp.	50	1.50
110-amp. to 200-amp.	25	2.50
225-amp. to 400-amp.	25	5.50
450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package 30%
1-5th to standard package 40%
Standard package 52%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package	$4.75 C
0-30 ampere, less than standard package	6.00 C

LAMPS—Below are present quotations in less than standard package quantities.

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B— Watts	Plain	Frosted	No. in Package	Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.35	$0.38	100	75	$0.70	$0.75	50
15	.35	.38	100	100	1.10	1 15	24
25	.35	.38	100	150	1.65	1.70	24
40	.35	.38	100	200	2.20	2.27	24
50	.35	.38	100	300	3.25	3 35	24
60	.40	45	100	400	4 30	4 45	12
100	.85	.92	24	500	4 70	4 85	12
				750	6.50	6 75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list

PLUGS, ATTACHMENT—

		Each
Hubbell, porcelain No. 5406,	standard package 250	$0.24
Hubbell composition No. 5467,	standard package 50	.32
Benjamin swivel No. 903,	standard package 250	.20
Hubbell current taps No. 5638,	standard package 50	.40

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$12 00	$14 00	$13 90	$25 00
12	13 25	15 70	18 05	30.70
10	18 30	21.00	23 85	41.50
8	25 54	28 60	32 70	56 77
6	...	...	51 40	....
4	...	....	70 00	.....
2	...	.....	101.80	.....
1	...	.....	131.86	.....
0	...	.....	160.00	.....
00	...	....	193.50	.....
000	...	.....	235 20	.....
0000	...	.....	288.60	.....

Prices per 1000 ft. for Rubber-covered Wire in Following Cities:

	Denver			Birmingham		
	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$11 25	$14.00	$31.00	$11 24	$15 39	$27.17
10	21.85	28.25	56.75	21 58	34.73	48.55
8	31.05	38.30	77.95	30 11	58.59	66 49
6	48 80	52.65		59 28	82 11	..
4	70.00	75.30	...	84 86	118 86	..
2	104.85	112.45	...	.....	155.40	.....
1	136.85	146.15	....	......	188 86	.....
0	......	194.25	.....	......	228.90	.....
00	.....	239.60	.....	......	279.30	.....
000	.....	294.00	.....	......	338.50	.....
0000	....	358.25	.....	......	446.75	.....

Pittsburg—23c. base; discount 50% St. Louis—30c. base.

SOCKETS, BRASS SHELL—

¼ In. or Pendant Cap.			½ In. Cap		
Key, Each	Keyless, Each	Pull, Each	Key, Each	Keyless, Each	Pull, Each
$0 33	$0 30	$0 60	$0.39	$0.36	$0 66

Less 1-5th standard package .... +20%
1-5th to standard package .... +10%
Standard package .... −15%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B.&S. regular spools (approx. 8 lb.)	36c. lb.
No. 18 B.&S. regular 1-lb. coils	37c. lb.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 50c. lb., 100 lb. lots	48c. lb.
Rubber tape, ¾ in., less 100 lb., 65c. lb., 100 lb. lots	60c. lb.
Wire solder, less 100 lb. 50c. lb., 100 lb. lots	46c. lb.
Soldering paste, 2 oz. cans Nokorode	$1 20 doz.

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$0 42	$0 68	$1.02	$1.36
60	.74	1 22	1.84	2.44
100	1 50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole Each
30	.70	1 06	1.60	2 120
60	1 18	1 80	2 70	3.60
100	2 38	3.66	5.50	7 3
200	4 40	6.76	10 14	13.50

Discounts:

Less than $10.00 list value	+ 5%
$10 to $25 list value	— 8%
$25 to $50 list value	—15%
$50 to $200 list value	—20%
$200 list value or over	—25%

POWER

Volume 50 New York, September 9, 1919 *Number* 11

Impressions of a layman after his first trip through a modern power plant

Coal and Wood Furnaces Under Stirling Boilers

Brief review of Willys-Overland boiler plants. The two furnace boilers are a feature. Estimates place the saving in coal for two 740-hp. boilers at $25,000 per year.

IN TOLEDO, the Willys-Overland Co. has developed into one of the largest automobile manufacturers in the country, the output of cars in 1917 reaching 175,000. A floor space of 109 acres gives an idea of the immensity of the plant. The forge shop has over 80 hammers ranging from 1500 to 5000 lb. and as usual all steam-driven. Other uses for steam are heating and drying and for driving air compressors, about 10,000 cu.ft. of air per minute at 100 lb. pressure being required in the various shops. Much of the electrical energy for light and power is purchased. Steam needs, however, have been met by installing boiler capacity in accordance with the growing demand. During the winter there is usually sufficient exhaust steam from the hammers and the air compressors to meet the heating and drying requirements, additional live steam being needed only in the coldest weather. As this exhaust steam is discharged into a long main of large diameter and considerable storage capacity, the back pressure is equalized and remains practically constant at 3 lb. gage. In the summer there is still need of exhaust steam for drying, and the balance is utilized in a mixed-pressure turbine driving through reduction gearing a 750-kw., 440-volt, 25-cycle generator. As the creek water used for condensing purposes is dirty and at high temperature in the summer months when the turbine is operated, the vacuum does not exceed 27 in., so that it has been found necessary to increase the back pressure to 4 or 5 lb. to get capacity, and live steam is used to meet any deficiency in the supply of exhaust steam to the turbine.

At the present writing there are three distinct boiler plants, No. 1 being the oldest and now held in reserve. It consists of three return-tubular boilers aggregating 325 hp. No. 2 boiler house has 1800 boiler horsepower in six units of the Heine type equipped with overfeed stokers. Coal is handled by a continuous bucket conveyor with worm feeds to each stoker, the hoppers having been enlarged to hold 10 tons each. Ashes are removed by a steam-jet vacuum conveyor. Closed heaters and direct-acting steam pumps take care of the feed water. The plant is equipped with damper regulators, steam flow meters, CO_2 recorders and a gas collector on each boiler so that an analysis of an average eight-hour sample may be made with an Orsat to check the recorders.

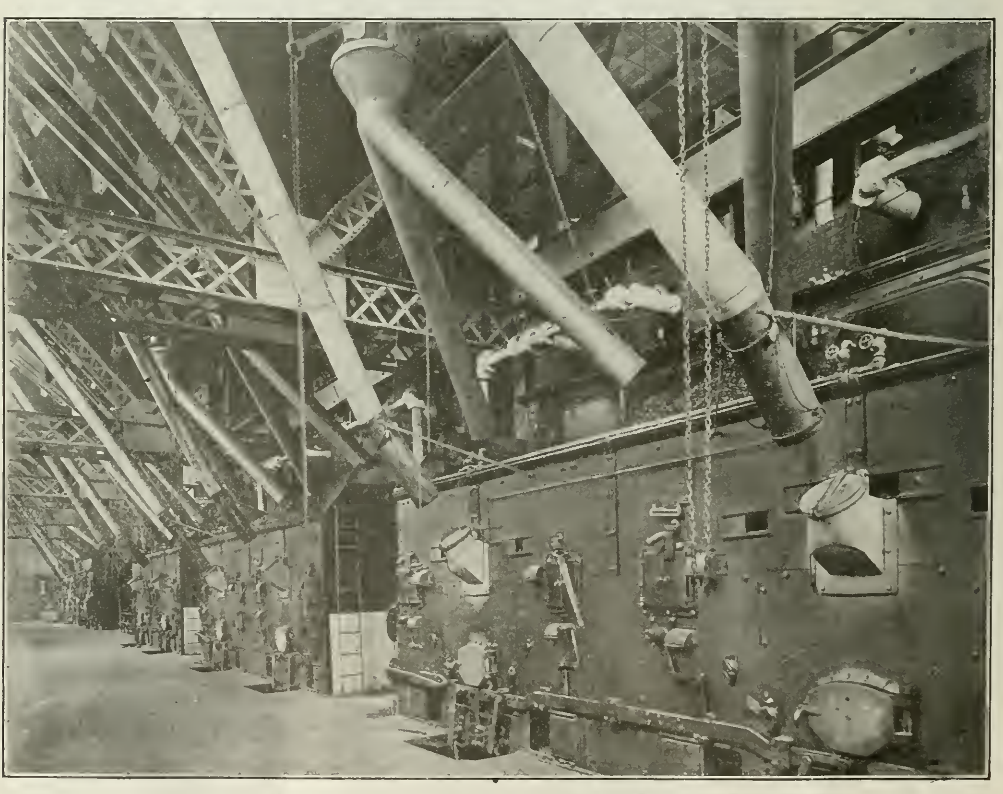


FIG. 1. THE TEN OLDER BOILERS IN THE WILLYS-OVERLAND STEAM PLANT NO. 3

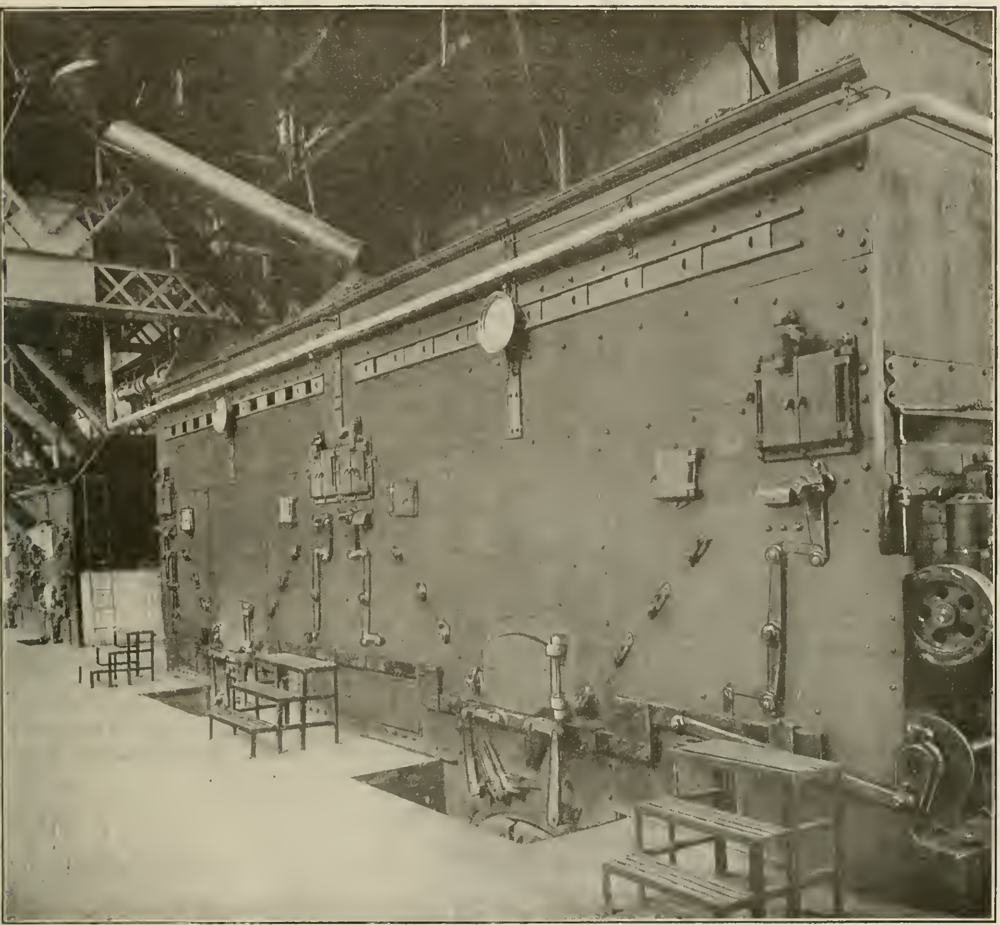


FIG. 2. NEW DOUBLE-FURNACE STIRLING BOILERS RECENTLY INSTALLED

Of the three plants No. 3 is the latest and largest. The aggregate capacity is 5300 boiler horsepower, consisting of six 300-hp. and four 500-hp. water-tube boilers served by V-type overfeed stokers and two 740-hp. Stirling boilers that have just been installed. To receive them the boiler house was extended and additions made to the coal and ash-handling equipment. In the older part of the plant the fuel during the day is largely shavings from the wood department. From a cyclone collection system provided with a "hog" to grind the larger pieces, the wood refuse is discharged directly into the furnaces through chutes entering at the front, there being no storage. The shavings are discharged on top of a coal fuel bed and by careful manipulation good combustion is maintained, the CO_2 averaging about 11 per cent. The furnaces are of the standard overfeed V-shaped type mounted as usual in a Dutch oven with a hole cut in the front face to admit the shavings. The records of the CO_2 recorders guide the firemen, and the analyses of the eight-hour samples from the gas collectors give the average CO_2 maintained on each boiler during each shift. Consequently there is a record of each fireman's work and at the end of each month the daily results are averaged and the figures posted for the benefit of the firemen. Working on a competitive basis they become interested in getting results and show active interest in maintaining economy.

The instruments now in use in the boiler room are practically the same as those in No. 2 plant and venturi meters for the feed water and coal scales have been purchased. There are damper regulators and air control for speed regulation of the stoker engines. The operating steam pressure is 160 lb. and the feed water is raised to 210 deg. in an open heater.

For the most part the feed water is returned from the heating and drying systems, and comes back to the boiler room at a temperature of 120 to 130 degrees. The makeup needed comes from the city mains. The water collects in a large receiving tank which has float control to admit makeup water directly from the city mains if necessary. From the receiver the water is delivered to an open heater under float control, which is at an elevation sufficient to give a 7-ft. head over the feed pump suction. A duplex direct-acting pump and a

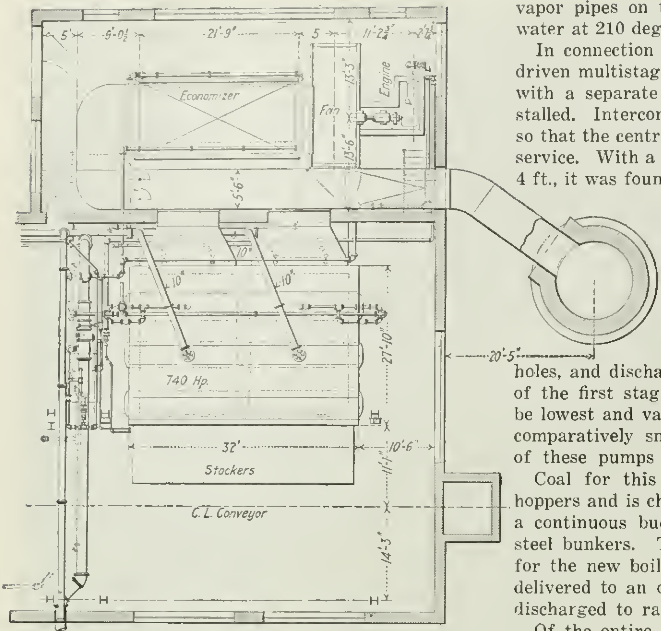


FIG. 3. PLAN VIEW OF NEW BOILER AND ECONOMIZER INSTALLATION

turbine-driven multistage centrifugal pump, each large enough to supply the ten older boilers under normal operation are generally used, as with the 7-ft. head and vapor pipes on the suctions they will handle the feed water at 210 deg. with no appreciable trouble.

In connection with the two new boilers one turbine-driven multistage centrifugal pump and an open heater with a separate V-notch meter and recorder were installed. Interconnection is made with the older system, so that the centrifugal may be thrown in on the general service. With a suction head on the new pump of about 4 ft., it was found that it would not handle water hotter than 150 deg. without becoming steam bound. Cold water jets to keep down the vapor were necessary, and these are located one in either leg of the V-casting forming the double suction entrance to the pump. The cold water is conducted through a ¼-in. pipe perforated with six ⅛-in. holes, and discharged into the casing against the vanes of the first stage, where the pressure would naturally be lowest and vapor would form more readily. With a comparatively small amount of cold water the service of these pumps was greatly improved.

Coal for this plant is dumped into railway track hoppers and is chuted down through rotary feeders into a continuous bucket conveyor delivering to individual steel bunkers. The system has been extended to care for the new boilers. By the same conveyor ashes are delivered to an overhead tank lined with firebrick and discharged to railway cars or trucks.

Of the entire steam generating equipment the latest addition is of particular interest, consisting as it does of Stirling boilers of standard design and baffling, equipped with overfeed coal-burning stokers and with wood-burning furnaces fed from the rear of the setting. It is the intention to alternate the fuels, though the two

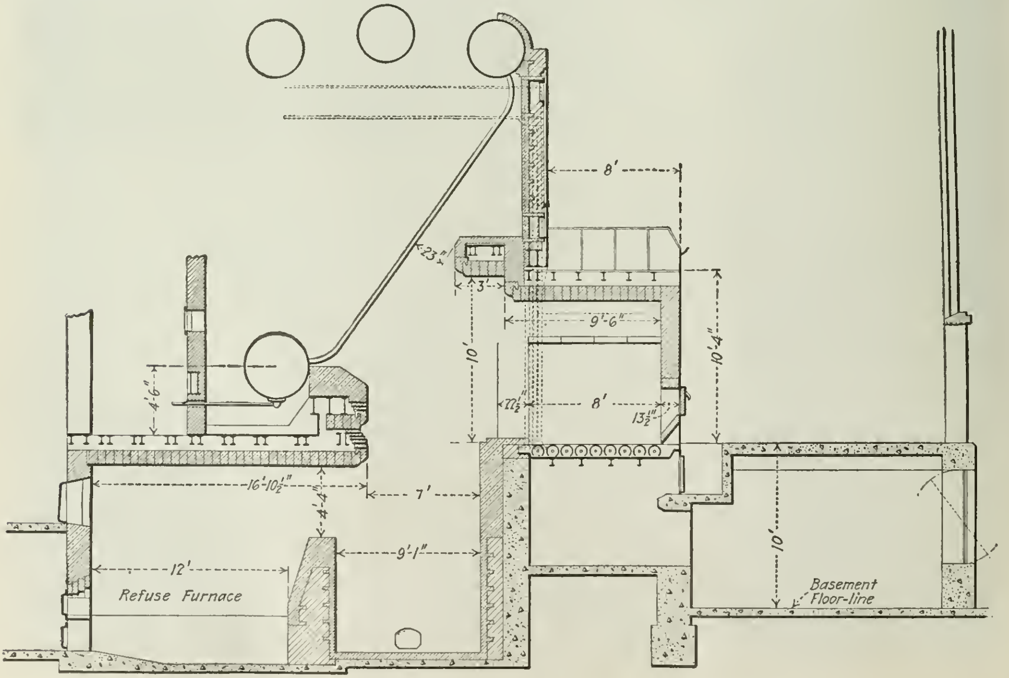


FIG. 4. SECTIONAL ELEVATION SHOWING LOCATION OF TWO FURNACES

perhaps may be burned simultaneously with some degree of success. Before the boilers were installed a great number of wooden boxes and pieces with nails and metal strips and all plant refuse had been burned on a vacant lot. The heat value in this wood and refuse will now be conserved and utilized to the fullest extent. It has been estimated roughly that the wood fuel reclaimed will save in coal $25,000 per year.

Fig. 3 is a plan of the new installation, and Fig. 4 a sectional view through the boiler setting showing the arrangement of the two furnaces. The wood-burning furnace has been placed below the boiler so that the gases discharge behind the stoker into a combustion chamber common to the two furnaces. The long flame travel required by a wood fire is provided and, excluding the passageway at the rear of the stoker, a combustion chamber having approximately 19 cu.ft. of volume per square foot of grate. The latter is of the herringbone type, 12 ft. long and 11 ft. wide, giving a ratio to steam-making surface of 1 to 56. Operating experience has emphasized the difficulty of removing nails and steel bands which adhere closely to the grate. To relieve the situation a magnet has been designed that can be swung in over the grate to draw out these obstructions. Firing doors have been placed in the front and near the top of the furnace and below is a cleaning floor with doors above and below the grate. At a height 9 ft. 4 in. above the grates is a flat suspended arch having the unusual length of 16 ft. 10 in. and the furnace width of 11 feet.

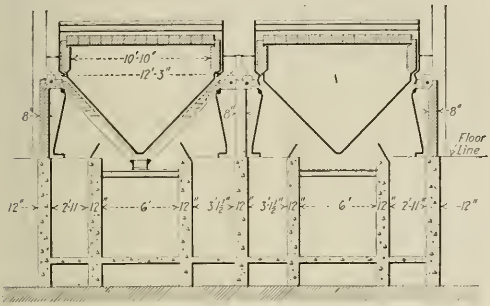


FIG. 5. SECTIONAL VIEW THROUGH OVERFEED STOKERS

The coal-burning furnace is equipped with a very large automatic stoker. A flat suspended arch instead of the sprung arch formerly used, makes a furnace width of 12 ft. 3 in. readily obtainable. The depth of the stoker is 8 ft., the projected area 98 sq.ft., and the active grate area 12.5 sq.ft., giving a ratio to steam-making surface of 1 to 61. In the combustion chamber the usual ventilated flat arch has been provided. Coal and ashes are handled as previously explained. From the wood furnace it is the plan to remove the ashes by means of a steam-jet vacuum system, although this equipment has not been installed.

On the average a little over 2 lb. of dry wood is equivalent to 1 lb. of the average quality of bituminous coal. As ordinarily dried in air the wood contains 25 per cent. moisture, and making deductions in proportion the heat value will approximate 6000 B.t.u. per pound. Due to the evaporation of this moisture and the likelihood of excess air, the combustion temperature is somewhat less than with coal, although in the present case the unusually large arch will help to maintain it at a high point. It is evident that with natural draft. if the two furnaces were operated simultaneously at rating, no advantage would be gained. The increase in the volume of the gas would cut down the draft and the mutual interference would no doubt result in an efficiency lower than would be obtained with either furnace alone. The plan, however, is to utilize the wood to an extent that the continuity of the supply will permit, the stoker serving as a standby to be brought in when necessary and operated at a rate sufficient to meet the demands on the boiler. With an induced draft fan of large proportions in connection with an economizer serving the two boilers, the above arguments may not hold. It will be interesting to see what the next few months bring forth.

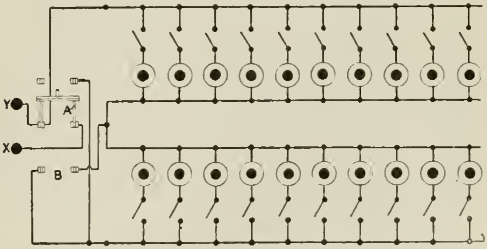
In the economizer there are 432 tubes $4\frac{5}{8}$ in. o.d. and 12 ft. long. The heating surface totals 7876 sq.ft. and for the passage of the gases there is an unobstructed free area of 52.33 sq.ft. As shown in Fig. 3, the economizer is placed to the rear of the smoke flue receiving the gases from the two new boilers. Passing in one direction the gases are drawn through the economizer by an induced draft steel-plate fan 12 ft. diameter and 6 ft. wide of the slow speed full housing type, and delivered back to the flue leading to the stack. It is driven by a 12 x 14-in. steam engine.

Engineers for the new work were Mills, Rhines, Bellman and Nordhoff, of Toledo, John Gillette of this firm having charge of the design and the installation work. For information concerning the plant we are indebted also to Orville Lindsey, chief engineer of heat and power, for the Willys-Overland Company.

A Simple 110- to 220-Volt Lamp Bank

By R. A. Phillips

In our plant we test our own watt-hour meters. While we had only 110-volt meters our lamp-bank load-box was a simple affair; but when the company complicated matters by giving us both 110- and 220-volt switchboard meters, it was necessary to rewire the lamp bank to meet the new condition. This was done by using a wider board for the base, and arranging the lamps in two rows instead of one, each row consisting of ten 110-volt lamps connected to a double-throw double-pole knife switch, as in the figure. With the switch in position *A*, both rows of lamps are in series, for use on 220-volt tests; while in position *B*, the two rows are in parallel for use on 110-volt tests. The lamp bank is connected to the circuit by the two binding posts, *X* and *Y*. Each lamp has in series a single-pole knife switch to obviate backing the lamps out in their sockets to regulate the load of the bank.



SCHEMATIC DIAGRAM OF LAMP BANK

The Possibilities of New Fuel Mixtures for Internal-Combustion Engines

BY E. HUMBOLDT

An article that deals with the production of a cheaper and cleaner substitute for gasoline by mixing with engine distillate a small amount of ether and alcohol. Economical methods for the production of alcohol and ether are described and the general use of such a mixture is predicted.

DURING the last few years there has been a tremendous increase in the manufacture and use of internal-combustion engines for motor cars, tractors, power boats, airplanes and all-around purposes generally, but the production of light fuels has not kept up with the demand. .

The big oil producers have been steadily increasing the gravity of their motor fuel for the purpose of increasing the supply, but the quality has been correspondingly lowered and the proportion of low-boiling-point products has become too small for satisfactory results. This is to be observed more particularly with engines that are hard to start in cold weather. True, some engines run fairly well with heavier fuel, such as engine distillate, kerosene or mixtures of both, and most engines can run on them when they have become sufficiently hot. These heavy fuels have a somewhat higher thermal value than gasoline and under proper conditions could be capable of a higher efficiency. But the ordinary engine is not built to use them economically.

HIGH BOILING POINT AND IMPERFECT VAPORIZATION

When using any fuel the boiling point of which is too high, the vaporization is imperfect and a good deal of the liquid is entrained with the air through the intake manifold as a fine spray or, rather, a mist. The explosion is not satisfactory because there is no intimate mixing of the liquid and the air. The combustion is imperfect, and the exhaust carries away a good deal of intermediate gaseous products and of course a corresponding amount of heat units. Moreover, the liquid spray coming into contact with the hot walls of the cylinder always "cracks" more or less and leaves a hard deposit of carbon which adheres to the metal parts and must be forcibly scraped away.

Engine distillate has gone the same way as gasoline—up in price and down in quality, so that what was bought a few years ago for 5 or 6 cents a gallon, costs now 13 cents or more. Leaving aside the petroleum products, one finds that there are few liquids susceptible of being used as engine fuel in a practical way and at a resonable cost; the lower members of the aromatic series, such as mixtures of benzol and toluol, with a small amount of naphthalene and other impurities, have a high calorific power and are fairly volatile, as well as low in price. However, the visible supply of those products is limited.

Alcohol is also a good fuel and one that has the merit of burning cleanly. At the present time it is too expensive for ordinary use in this country and the supply is limited as well. Still, there is an abundance of materials capable of being used in its manufacture, and whenever our Government sees fit to remove a part of the red tape that fetters that industry, we shall most likely see industrial alcohol produced cheaply and in large quantities. There is no doubt that under proper conditions and by taking care of the byproducts of the fermentation, it could be manufactured at a cost well under 25c. per gallon in some of the large plants that were built for war purposes, but it is doubtful whether it will ever sell at such a low price under a heavy demand —at least not for some time to come; consequently, its use as an all-around fuel need not be given any immediate consideration, inasmuch as it can be used to best advantage only in engines specially built for that purpose.

ALCOHOL AND BENZOL MIXTURE

Although alcohol burns cleanly, leaving neither smoke nor coke, it has not so high a calorific power as benzol, and a mixture of both, in the right proportions, is better for all purposes if something else, like gasoline, is used for starting. When the engine is heated up, it generally runs very well on such a fuel. The Germans made good use of it during the war for airplane work, a separate tank containing gasoline being used for starting the engine. It was then cut out as soon as the machine had attained a speed at which it could use the higher fuel.

The relatively high prices of all those liquids and their troublesome use, as well as their scarcity at the present time, prevent them from coming into universal use, although in special cases they may prove to be just the right thing.

All kinds of "dopes" have from time to time been put on the market as carbon removers, boosters, etc., and all kinds of claims have been made regarding the performance of those compounds. Some were going to take the place of gasoline; others would nearly double the mileage and reduce enormously the cost of running a machine, and so on. And naturally, in spite of their slight cost, they have been put on the market at exorbitant prices. As carbon removers most of them are fairly good, although too costly, but their other qualities exist too often only in the dreams of their promoters, and this is probably the reason why most of them are not quite successful, commercially, and sooner of later die of oblivion.

ALCOHOL AS A CARBON REMOVER

Alcohol, when mixed with either gasoline, engine distillate or benzol, makes a very efficient carbon remover, or rather a carbon preventive. One of its derivatives, ethyl oxide, or ether, is also a substance which gives a clean combustion and, moreover, possesses a very low boiling point, about 35 to 36 deg. C. for the commercial product, which is much lower than that of gasoline. It mixes in all proportions with alcohol and possesses the remarkable property of being soluble in the petroleum hydrocarbons and of increasing the solubility of alcohol in those same bodies.

Gasoline and distillate behave much the same in regard to alcohol, ether and their mixtures; they dissolve about 5 per cent. of alcohol at ordinary temperature, while alcohol dissolves nearly 135 per cent. of gasoline. If both are mixed in such proportions that the alcohol be more than 5 per cent. of the gasoline and less than 135 per cent., the mixture will separate by standing in two separate bodies with a sharp surface of separation. One is alcohol saturated with gasoline, and the other just the opposite. Ether behaves in a different way. It dissolves slowly and produces a slightly turbid liquid which clears after a while. By using a mixture of ether and alcohol, the turbidity is more pronounced, and finally a small amount settles out of a liquid composed of alcohol, ether, water and gasoline. The amount separated varies with the proportion of the various components, the water content of the alcohol, and also with the temperature. In all cases the amount is small, and the separated liquid burns readily and completely, unless the alcohol used contained too much water.

ALCOHOL AND ETHER MIXTURES

At the ordinary temperature a mixture of two-thirds ether and one-third alcohol dissolves about 3.06 parts of distillate, and one-half ether and one-half alcohol only 2.36 parts of distillate or gasoline. Whenever the proportion of hydrocarbon is above that amount, the solution is not complete at the ordinary temperature and the mixture is more or less milky, but settles very rapidly. Of course, if the ether is fairly well dehydrated and mixed with alcohol of not less than 95 per cent., or 190 proof, the liquid separated at the bottom does not contain very much water and burns readily; consequently, it does no harm whatever. Using alcohol of a lower proof simply results in more water separating and collecting at the bottom of the mixing or settling vessel, whence it can be drained out.

At the close of the war the company with which the writer is connected, like many other firms, found itself not only with a large plant for the manufacture of alcohol, which could not be run to full capacity, but also with a fairly good-sized stock on hand, which it was practically impossible to reduce or to dispose of immediately. Moreover, it had a large amount of molasses in storage and contracts for a good deal more for future deliveries. Of course molasses finds a ready market and a large outlet has been found in the manufacture of stock feeds; consequently, no anxiety need be felt on that account. Still as it was not convenient to close down the distillery, an outlet had to be found for the alcohol, and its use for fuel was one of the first that presented itself and the one that seemed to hold the best promise of success.

DISTILLATE, ETHER AND ALCOHOL

Starting from the assumption that the price of distillate will remain comparatively low for some time to come, it seemed rational to take ordinary engine distillate, add to it the right proportion of a mixture of alcohol and ether and correct two of the main disadvantages attending the use of that hydrocarbon as an engine fuel, prevent the formation of carbon in the engine cylinders, and add a sufficient amount of low-boiling-point products to provide easy starting.

After some experiments on a small scale it was decided to try a compound of 8 parts of engine distillate, two-thirds of ether and one-third of alcohol in a six-cylinder automobile engine. The object was to find out how the fuel would act on the engine and how it would compare with ordinary gasoline for efficiency, ease of starting and sensitiveness to control. Several runs were made, varying from 50 to 200 miles and aggregating over 1000 miles, covering all kinds of road conditions, speed and loads.

Shortly after starting on this fuel the engine began to act queerly, sputtered, and finally stopped altogether; after a short stop the engine started easily but did not respond to control and soon stopped again. On taking out the carburetor, it was found to be plugged with scale and dirt.

Also the pipe connecting the vacuum and the supply tanks was plugged. The whole feed system was thoroughly cleaned and the tank filled up again. The engine ran for about one day in a satisfactory way, then began to act queerly again. Another good cleaning was given the fuel-feed system from one end to the other, and since that time it has given no trouble.

Of course the carburetor, feed pipe and supply tank had not been cleaned since the machine was first put into commission and the dirt which had accumulated during that time was covered over with a greasy film left by the gasoline itself. So long as nothing but gasoline was used in the machine, that sediment collected undisturbed, but the alcohol loosened it and allowed it to run with the liquid and collect where it would surely call attention to its presence.

The spark plugs were practically clean all the time, showing neither carbon nor corrosion but just a small amount of loose and light soot. The pistons and cylinder heads were originally covered with hard coke, but the last time those parts were examined they were absolutely clean.

A mixture of two-thirds ether and one-third alcohol compounded with from twenty-five to forty times its volume of gasoline, was tried on a motorcycle for several days in succession with the same results. The motor started easily—much more so than with gasoline alone—gathered up speed quickly and picked up the load without any trouble. The spark plugs and the cylinders, which were coated with carbon at the beginning, were cleaned and remained bright and smooth for the rest of the trial.

RESULTS OBTAINED FROM EXPERIMENTS

From these experiments we can conclude that the addition of alcohol to the ordinary petroleum fuels prevents them from forming any carbon deposit in the engine, and insures a thorough, clean combustion. The addition of ether insures a better solution of the alcohol in the hydrocarbon. It is also a carbon preventive, and secures the necessary product of low boiling point for easy starting. At the same time both ether and alcohol have a fuel value not to be despised.

It should be remarked that the solution of alcohol and ether in gasoline or distillate behaves at distillation like a good many other mixtures of liquids of different boiling points. A true separation can be obtained only after repeated, careful rectifications. This is a distinct advantage, because the ether in its evaporation entrains a large proportion of alcohol and hydrocarbons boiling at a higher point than ether alone, but much lower than either one of the others. Thus, a relatively small amount of ether generates a sufficient quantity of fairly low boiling product to insure a good, rich explosive mixture and easy running at a low temperature.

The next series of tests were made with benzol. Most of the experiments were made with a mixture of eight parts of benzol and one part of one-third ether and two-thirds alcohol, although other proportions were tried also. An excess of ether, such as two-thirds ether and one-third alcohol in sufficient quantities to prevent coking, is not satisfactory. The engine starts very easily, but as soon as it begins to work hard, the rapid evaporation produces an enormous cooling of the carburetor, which I have seen several times covered with frost. The consequence is that it is unable to pick up the load and acts as if the feed pipes were obstructed. A jacket on the carburetor does not help matters either, unless there is a special provision for cutting down the amount of fuel.

Carburetor Float Should Be Metal

It should also be remembered that benzol dissolves the shellac coating on the carburetor float, and the float should preferably be made of metal, or at least of a single piece of cork, and small enough to allow for a little swelling. Under these conditions, no trouble need be anticipated. The mixture of gasoline or distillate, ether and alcohol, as used in trial runs, has scarcely any effect on shellac.

As has been said before, the supply of benzol is limited, and relatively small. Unfortunately, it is not the habit of American manufacturers to save their byproducts, and material which might become very important is thrown away. It is to be hoped that the events of the last few years may teach them a much-needed lesson, and that in the very near future nothing will be wasted that may be put to good use. The production of benzol and alcohol can be greatly increased, and their conservation will surely prove a great boon when the supply of light petroleum begins to run low.

The manufacture of ether from alcohol is a simple matter, and to those who are accustomed to look upon ether as a rare and expensive chemical, the writer would say that it can be made for less than 10 per cent. over the cost of alcohol. There are, however, more recent and better processes for its manufacture which, by using alcohol in the vapor phase, produce very pure products with a better yield, and consequently much lower cost. The installation is simple and cheap, and the operation, which involves nothing but temperature control, is so simple that anyone of ordinary intellect can handle the apparatus.

Among those processes the two best ones only will be briefly described because they have proved their worth. The first one consists of superheating the alcohol vapor to the right temperature and then either forcing it through the dehydrating bath kept at the same temperature or rejecting it in a tower filled with resisting material, over which flows the acid, also preheated. The outgoing vapors, before condensing, are partly cooled through several heat exchanges in which the alcohol is vaporized and partly superheated. In this way the conversion of alcohol into ether is much more complete. There need be no overheating no production of permanent gases and consequent waste of alcohol; and the amount of heat necessary for the conversion is less than 10 per cent. of that in the old Barbet or Williamson apparatus. The other process consists in passing alcohol vapors, previously superheated, over alumina acting as a catalyst, also heated at that same temperature. When the time of contact is sufficient, the conversion is easily 90 to 95 per cent. and if the right temperature has been accurately maintained, there is no loss of alcohol and the vapors issuing from the converter are composed only of ether, water and a little alcohol. But if the temperature is allowed to rise to 290-300, ethylene is formed in increasing proportions, until at 300 to 400 deg. there is no ether left. The contact material must be in suitable shape so as to present as much surface as possible and not offer too much resistance to the passage of the vapors. The outgoing vapors are naturally at the same temperature as the converter, about 200 deg. C., and they are passed through a number of tubular heat exchanges, well insulated, when they give up the heat to the alcohol to be evaporated and to the alcohol vapor itself, so that the small superheater is all the necessary heating appliance.

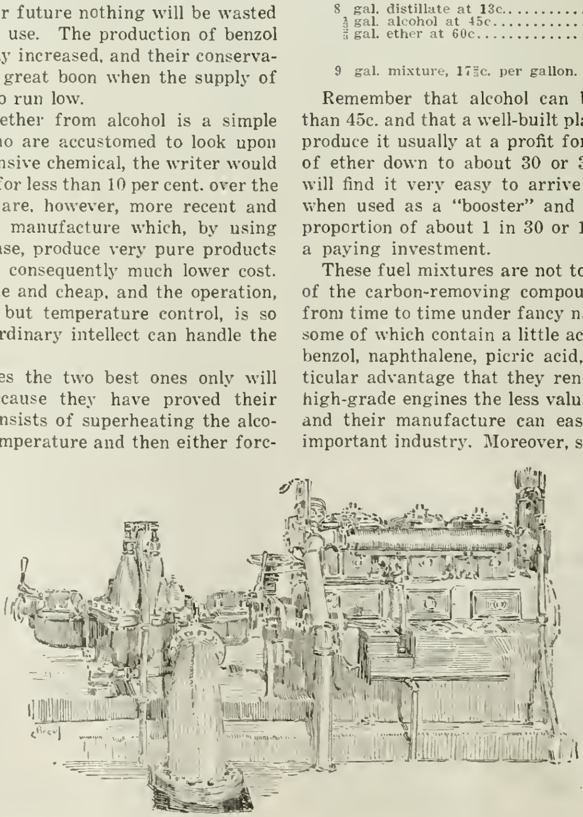
Cost of the Mixture

As to cost, adding the mixture of ether alcohol to distillate, and taking ultraconservative figures of 45c. a gallon for alcohol and 60c. for ether, we would have:

8 gal. distillate at 13c.	$1.04
⅓ gal. alcohol at 45c.	0.15
⅔ gal. ether at 60c.	0.40
	$1.59
9 gal. mixture, 17⅔c. per gallon.	

Remember that alcohol can be made for much less than 45c. and that a well-built plant of large capacity can produce it usually at a profit for 25c., bringing the cost of ether down to about 30 or 35c. maximum, and you will find it very easy to arrive at conclusions. Even when used as a "booster" and carbon remover, in the proportion of about 1 in 30 or 1 in 40 of gasoline, it is a paying investment.

These fuel mixtures are not to be compared with most of the carbon-removing compounds put on the market from time to time under fancy names and at high prices, some of which contain a little acetone and benzol, others benzol, naphthalene, picric acid, etc. They have a particular advantage that they render available for use in high-grade engines the less valuable petroleum products, and their manufacture can easily develop into a very important industry. Moreover, since there is little likelihood of the fuel supply exceeding the demand for a long time to come, there can hardly be any competition of the kind which is ruinous to manufacturers. On the contrary, with prohibition coming on it will open up a market for all the surplus alcohol already accumulated and utilize a large percentage of our present industrial waste.

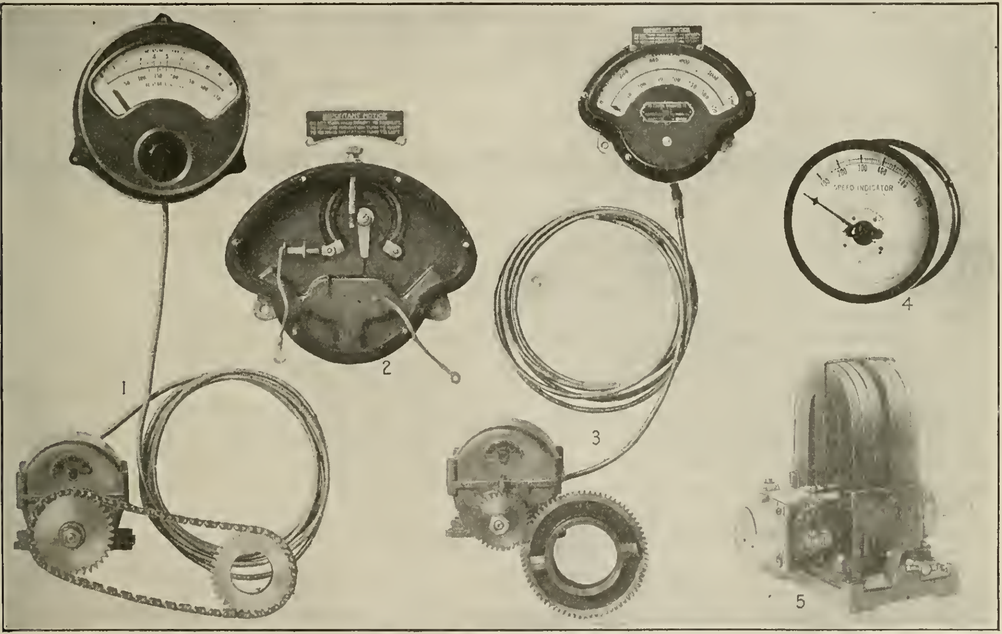


Electric Speed Indicators

By VICTOR H. TODD

The principle of operation, constructional features, method of gearing and application of electric speed indicators are discussed.

THE electric speed indicator consists essentially of two parts: a small direct-current magneto-generator, which is chain-driven or geared to some rotating shaft of which it is desired to know the speed, and a direct-current voltmeter or millivoltmeter, preferably of the permanent-magnet moving-coil type. The magneto generates a voltage directly proportional to its speed, and since the pointer deflection is proportional to the applied voltage, the scale on the indicator may be marked to indicate directly the speed of the shaft or any terms which are a function on this speed.



FIGS. 1 TO 5. SHOWS DIFFERENT TYPES OF ELECTRIC SPEED INDICATORS

A typical outfit for an automatic stoker is shown in Fig. 1. The indicator is marked to indicate the revolutions per minute of the line shaft and the corresponding r.p.m. of the stoker shaft. The long flexible cable enables the indicator to be placed at any convenient point, for instance, over the engineer's desk, or in the manager's office. The magneto is provided with a sprocket wheel and chain; also a driving sprocket wheel, the latter to be fastened on the line shaft. The generator is very accurately constructed, using permanent magnets for the field poles. The commutator is made of 14 karat gold and the brushes of 18 karat gold to insure an accurate voltage over a long period of time. One bearing has no outlet while the other is provided with a watertight construction. Fig. 6 shows a graph of the voltage generated. It will be noted that the magneto generates a voltage directly proportional to the speed from 0 up to 1800 r.p.m. at which speed it generates about 950 millivolts. In Fig. 5 is another magneto which generates 20 volts at 1000 r.p.m. The meter with which this machine is used is shown in Fig. 4.

In calculating the speed indicator outfit, gears or sprockets should be selected to give a normal magneto speed. Of course, the magneto need not be run directly from a slow-moving or fast-moving shaft; it may be run from any suitable shaft the speed of which is proportional to that of the speed to be indicated.

For instance, on a gasoline engine, instead of gearing the magneto to the flywheel shaft running at 2000 or more r.p.m., it may be geared to the camshaft running at one-half the speed of the flywheel. If, however, a shaft of suitable speed is not available, it is necessary to provide suitable gearing. For instance, assume it is desired to indicate the speed of a steam engine running 250 r.p.m. If the speed of the magneto should be about 1000 r.p.m. it follows that a 4 to 1 gear or chain must be used, then, if the magneto's gear has 40 teeth, the gear on the engine shaft must have 40 × 4 or 160 teeth. If the meter reads full scale at 1000 r.p.m. of the magneto, the full-scale point may be marked 250 r.p.m., as this engine speed will produce full-scale deflection of the meter.

In some cases it is desirable to provide for overspeed. In this case, the speeds are figured as before, but the meter is adjusted to read only about three-fourths or two-thirds of full scale at the normal point. For instance a machine may have a normal speed of 2000 r.p.m., but may have occasion to run as fast as 3000 r.p.m. at times. The sprockets or gears would be selected with a 1 to 2 ratio to give 1000 r.p.m. of the magneto at normal speed. At 3000 r.p.m. the magneto would make 1500 r.p.m., consequently the meter would be adjusted to give full-scale deflection on 1500 r.p.m., but this point would be marked 3000 r.p.m. and the other points proportionally.

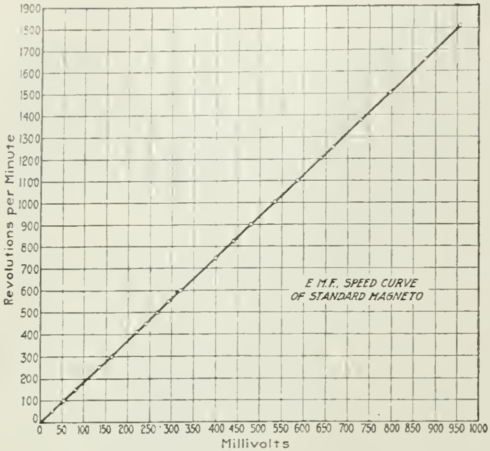


FIG. 6. VOLTAGE CURVE OF MAGNETO, FIG. 1

Fig. 3 shows an important application of an electric speed indicator. This meter indicates the speed of the stoker's line shaft and also the "pounds of coal per hour" which is burned under the boiler. As stated before, this meter may be installed where the engineer can tell at a glance just how fast the coal is being consumed. The meter in Fig. 1 is a similar application but indicates the r.p.m. of the stoker shaft. The rear view of the indicator, Fig. 3, is shown in Fig. 2. This discloses a small circular-shaped rheostat which may be operated by the little thumb nut on top of the meter. In case of a slight discrepancy between the speed of the shaft and its indication on the meter, the rheostat may be shifted until the two correspond.

Other applications are on air compressors; or fans to indicate their speed and also the air delivery per hour, so that the quantity of air necessary for complete combustion of coal may be accurately known. Water pumps may have their indicators calibrated to indicate the rate of discharge or flow in gallons or cubic feet per minute or hour. Speed indicators may also be used in place of frequency meters.

Using Indicator on Internal Combustion Engines

By RALPH MILLER

THE two light-spring cards shown herewith offer an interesting illustration of what the oil-engine diagram can show us. Both were taken from 23 x 24-in. four-stroke-cycle oil engines running at 150 r.p.m. No. 1 engine is located 7000 feet above sea level; No. 2 is near sea level. The elevation, however, has no bearing on the comparisons which we will draw between the cards.

These diagrams were taken with an 8-lb. spring and show only that part of the total diagram which lies below the atmospheric line and 10 to 11 lb. above it. In order to take such a card it is necessary to use a stop. A piece of brass tube fitted over the indicator piston rod and cut to a suitable length will prevent damage to the spring.

Only two complete strokes of the cycle appear—the exhaust and intake strokes. The former helps to determine the back pressure that the exhaust must overcome. This should, of course, be kept as low as possible, and with well-designed exhaust piping utilizing the kinetic energy of the exhaust gas column it is possible to lower the back pressure almost to the atmospheric pressure. Referring to diagram No. 1; the exhaust line indicates a too long and obstructed exhaust pipe. Investigation showed this to be true. Diagram No. 2 had a much shorter exhaust pipe with few elbows, and the card plainly shows the advantage.

The line representing the intake stroke falls, of course, below the atmospheric line and shows at a glance whether the air passages are free. In large, moderate-speed engines the suction pressure should not go lower than 2 lb. below atmospheric.

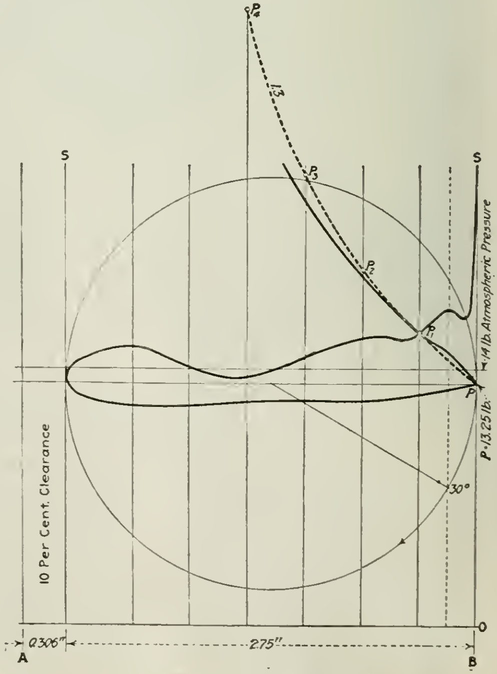


FIG. 1. SHOWING OBSTRUCTED EXHAUST AND LOST COMPRESSION

The next line on the card representing the compression stroke, is found to be the most interesting and useful; however, in order to read the compression line the theoretical adiabatic compression curve must first be laid out. The engine in question has a compression of about 290 lb. absolute. The clearance space, therefore, is about 10 per cent. of the cylinder volume. Proceeding to lay out a theoretical compression curve P_1 P_2 P_3 P_4 add the clearance to the diagram in the same scale as the length of this represents the piston displacement. Divide the total length A B into an equal number of parts, say eight, and raise perpendiculars 1, 2. 3, 4, 5, 6 and 7, as on diagram No. 1. Mark the atmospheric line with the barometric pressure at the time the card was taken in pounds per square inch. Draw in the zero line. If the atmospheric pressure were 14 lb. and an 8-lb. spring had been used, the zero line would lie $1\frac{3}{4}$ in. below this. Now measure the pressure at the beginning of the compression stroke. For instance, if the compression line touches the perpendicular S-B $\frac{1}{8}$ in. below the atmospheric line, the initial compression pressure will be 1 lb. less than the atmospheric. This pressure we will call P, or the initial pressure of compression in absolute pressure. To find point P in perpendicular 1. use the formula $P_1 = P \times \frac{V^n}{V_1{}^n}$ For instance, on card No. 2 $P = 13.25$, $V = 8$, $V_1 = 7$ and we have $P_1 = 13.25 \times \frac{8^{1.3}}{7^{1.3}} = 13.25 \times 1.19 = 15.8$ lb. absolute. Having used an 8-lb. spring point, P_1 is $15.8 \div 8 = 1.97$ in. above the zero line. In the same way find points P_2 P_3 P_4 by substituting $6^{1.3}$, $5^{1.3}$ and $4^{1.3}$ respectively in the formula and draw the curve through these points.

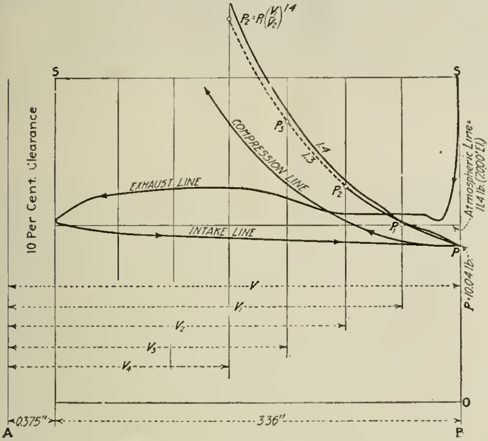


FIG. 2. SHOWING LITTLE COMPRESSION LEAKAGE

The exponent n in this case is taken as 1.3. It may vary in value between 1.25 and 1.45. However, for the purpose of checking up the condition of an engine by making comparisons between cards taken from time to time, it is of course advisable to always use the same exponent, and 1.3 will give a curve — lying close to the actual. High jacket-wall temperatures or a hot engine tends to increase the value of n, while leakage, such as loose fitting pistons or leaky valves, lowers its apparent value.

It will be seen at a glance that the engine from which diagram No. 1 was taken was losing compression. It is not quite plain, however, why the beginning of the compression line makes a loop with the intake line. Probably some of the readers can explain this phenomenon.

Diagram No. 2 shows very little compression leakage. Valves and pistons are in good condition. It will be seen that the presssure at the beginning of the stroke rises above the theoretical curve. This is due to the kinetic energy of the incoming air. During the suction stroke the air column in the suction pipe acquires a high velocity, which causes it to rush into the cylinder some time after the piston has started on the compression stroke. For this reason the suction valve is not closed on dead-center, but between 25 and 35 deg. after.

Improper Setting of Valves Caused Alternator to Hunt

By Arthur Hearvey

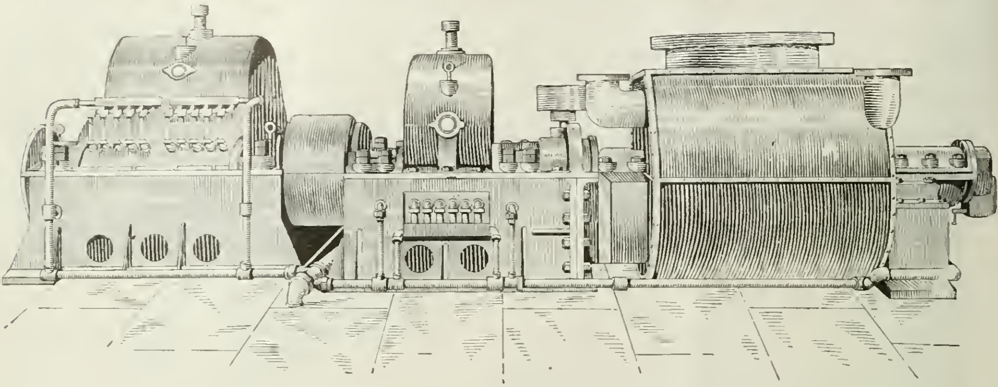
In a large paper mill where telautographs are being operated by current supplied by an exciter, direct-connected to a synchronous motor, trouble with illegible writing was experienced after three months' satisfactory service. The mill machinery was driven by 440-volt induction motors, the current being generated by two direct-connected alternators. A synchronous motor was used to correct the power factor and drive a direct-current generator in addition to its exciter.

The electrical engineer who was called in to locate the trouble observed that the armature of the synchronous motor was swinging back and forth in its bearing in step with the engine that was driving the alternator which was in use at the time, and that the hum of the motor fields also changed its note in time with the stroke of the engine. A voltmeter connected across the brush-holders of the exciter showed a slight variation in the voltage; this change of about one volt was causing the trouble in the telautograph.

The second alternator was put on the board and the first one disconnected. As soon as this change was made, all trouble stopped and the motor current dropped from 40 to 10 amperes. It was evident that the motor, working perfectly on one alternator, was not at fault. An examination of the first alternator showed it to be in first-class condition. The blame was therefore put upon the engine.

The log showed that the engine had been overhauled and the valves reset when the steam pressure was at 80 lb. with a load of 50 amperes on the alternator. The working pressure and load were 120 lb. and 200 amperes, respectively. The engine was indicated at full load and found to be taking steam for two-thirds stroke on the head end and about one-sixth stroke on the crank end. Engineers who have set the valves on high-speed four-valve engines know that they must be set for the average load at correct pressure, as the distribution of steam changes with the load. After resetting the valves, the motor and alternator operated without any further indications of trouble. This was unquestionably a case of hunting between the synchronous motor and the alternator due to a variation of the latter's angular velocity. The conditions causing hunting between two alternators are similar to those between an alternator and a synchronous motor, and the former are much easier to prevent.

STEAM TURBINES AND GEARS FOR MARINE SERVICE*



Showing the advantages of turbine drive with reduction gear for ship propulsion, some of which are greater speed for a given weight of power plant, less operating expense, greater reliability, saving in fuel and greater efficiencies.

THE advantages of the steam turbine over the reciprocating engine for ship propulsion, may be summarized in the main as: greater speed from a given weight of power plant, greater steaming radius or greater speed from the same weight of fuel or cargo carrying capacity with the same speed or steaming radius; also lessened expense for attendance and supplies, and increased reliability, as shown by less time lost in over-hauling and repairs. These advantages of the steam turbine appear in maximum degree when the geared steam turbine, rather than the direct-drive turbine, is compared with the reciprocating engine.

The best speed for a steam turbine, in the interests of efficiency and simplicity, lies somewhere between 1500 r.p.m. for a turbine of 20,000 hp., and up to 5000 or 6000 r.p.m. for comparatively small powers. The best speeds for propellers, especially for cargo vessels, are in the neighborhood of 100 r.p.m. Attempts to design an efficient high-speed propeller have been practically abandoned.

For very large powers the steam turbine running at slow speed can be used with less loss than for moderate or small powers, but even so, speed-reducing gears give better economy as compared with direct drive, due to the more favorable speeds at which both turbine and propeller can be operated.

Turbine-Drive Efficiency

The saving in fuel of the geared turbine over the direct-drive turbine follows from the greater efficiency of the propeller when operated at slow speed and of the turbine when operated at high speed. In the largest vessels, where conditions are most favorable to the direct-drive turbine, the saving made by the geared turbine is 10 to 15 per cent. In small vessels the difference is greater, as small steam turbines running at slow speeds lose excessively through leakage.

As compared with the reciprocating engine, the geared steam turbine is able to offer much better overall plant efficiency, due principally to the fact that it can utilize to advantage the highest superheat and vacuum.

The steam turbine is satisfactory and reliable when using steam superheated to any degree likely to be introduced in marine practice. The steam consumption of the turbine is improved approximately 1 per cent. by each 12½ deg. F. of superheat. The ability of the steam turbine to utilize high vacuums, as compared with the reciprocating engine, is remarkable. Little benefit is gained by reciprocating engines from increase of vacuum above 26 in., as the low-pressure cylinders and the valve ports are not able to handle the steam at the enormously increased volume. Steam turbines, on the other hand, show an increase in economy from higher vacuum nearly equal to the increased amount of heat available from the increased temperature range, or at least 8 per cent. between 28 and 29 in. vacuum referred to a 30-in. barometer.

The greater temperature range from higher steam pressure, higher superheat and higher vacuum is decisively in favor of the steam turbine as compared with the reciprocating engine. The steam turbine does not suffer a rapid decrease in efficiency, as does the reciprocating unit, from leakage past valves and piston rings, but maintains a good steam economy indefinitely. A gain in fuel economy of approximately 25 per cent. can be made through the installation of geared turbines, over that possible with the ordinary marine-reciprocating engine of the same capacity.

Saving in Space

The saving in space through the use of geared turbines will be self-evident from a few examples.

The turbine and gear shown in Fig. 1, supplies 1500 shaft horsepower, but occupies a space only 21 ft. 2¾ in. long, 9 ft. 2¾ in. wide and 7 ft. 10 in. high, that is 1328 cu.ft., or 1.13 hp. per cu.ft. A geared turbine unit of 3000 hp. is only about 1½ ft. longer, 2 ft. wider, and about 1⅗ ft. less in height, occupying altogether about 1530 cu.ft., or 1.96 hp. per cu.ft. It weighs approximately 110,000 pounds.

An analysis of a number of reciprocating engine installations indicates that their weight is 50 to 100 per cent. greater than that of geared turbines. A com-

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*From data supplied by Geo. H. Gibson.

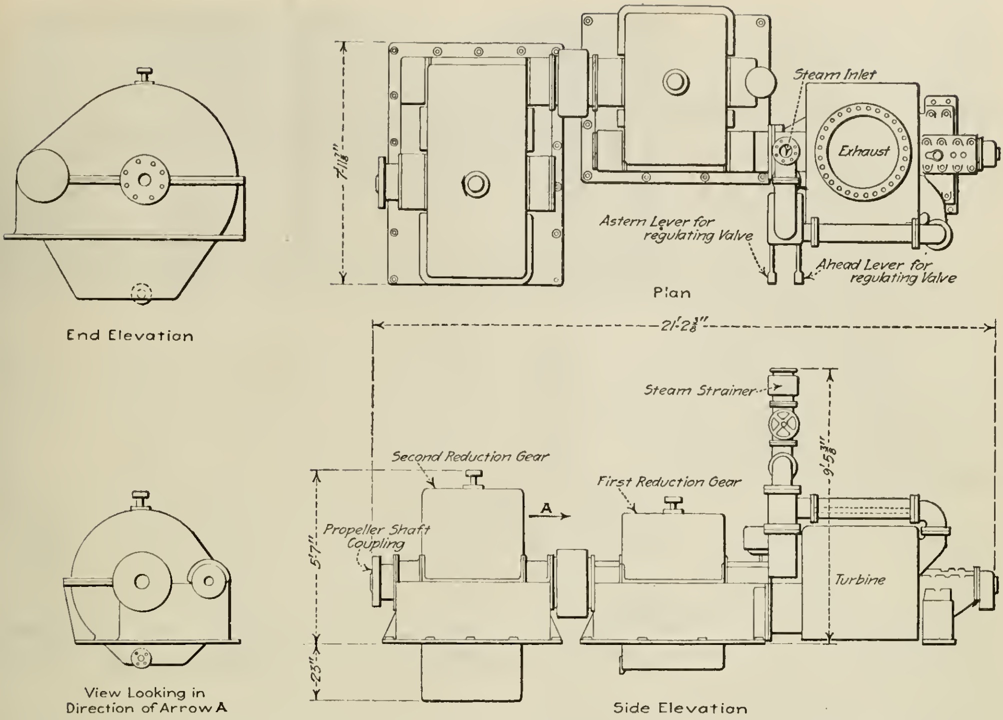


FIG. 2. PLAN AND SIDE ELEVATION OF MARINE TURBINE WITH SINGLE-PINION REDUCTION GEAR

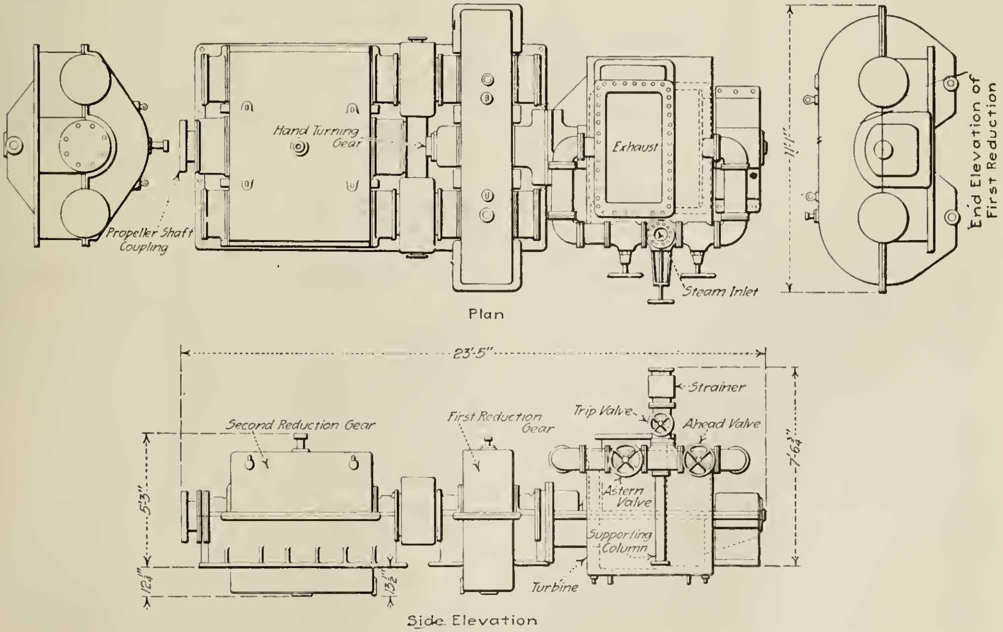


FIG. 3. PLAN AND ELEVATION OF A 3000-HP. UNIT WITH DOUBLE-PINION REDUCTION GEAR

parison of the cubical space requirements indicates approximately the same relative difference. For example the standard type 2500-hp. triple-expansion marine engine running at 90 r.p.m. weighs about 250,000 lb. and occupies a space of 20 ft. by 11 ft. 9 in. in plan and 21 ft. 3 in. above the floor level, or 5000 cu.ft., that is only ½ hp. per cu.ft. In larger powers the compactness of the geared turbine is still more apparent.

The arrangement of turbines and gears depends in any instance primarily upon the power and speed of the ship. For ratios up to 1 to 24, a single reduction may be used. There may be either one or two pinions. With two pinions the turbine is divided into high- and low-pressure sections, both, however, arranged to receive high-pressure steam, if necessary. Where a greater ratio of speed reduction is required, as on cargo ships, a double reduction is used. For small power, both high- and slow-speed gears may be of the single-pinion type as shown in Fig. 2, but for larger power and slow speed vessels the arrangement is generally as in Fig. 3.

Fig. 4 gives general dimensions of a 2500 hp. unit having independent high- and low-pressure turbines driving the propeller through a two-pinion single-gear reduction. This type of unit, while more expensive than the single turbine drive, is more efficient. The unit is so arranged that either high- or low-pressure turbines can be operated on high-pressure steam and exhaust to the condenser. Either turbine can be disconnected in case of accident, and the speed of the vessel can be maintained within approximately 30 per cent. of normal with only one turbine in operation which is not possible with the single turbine drive.

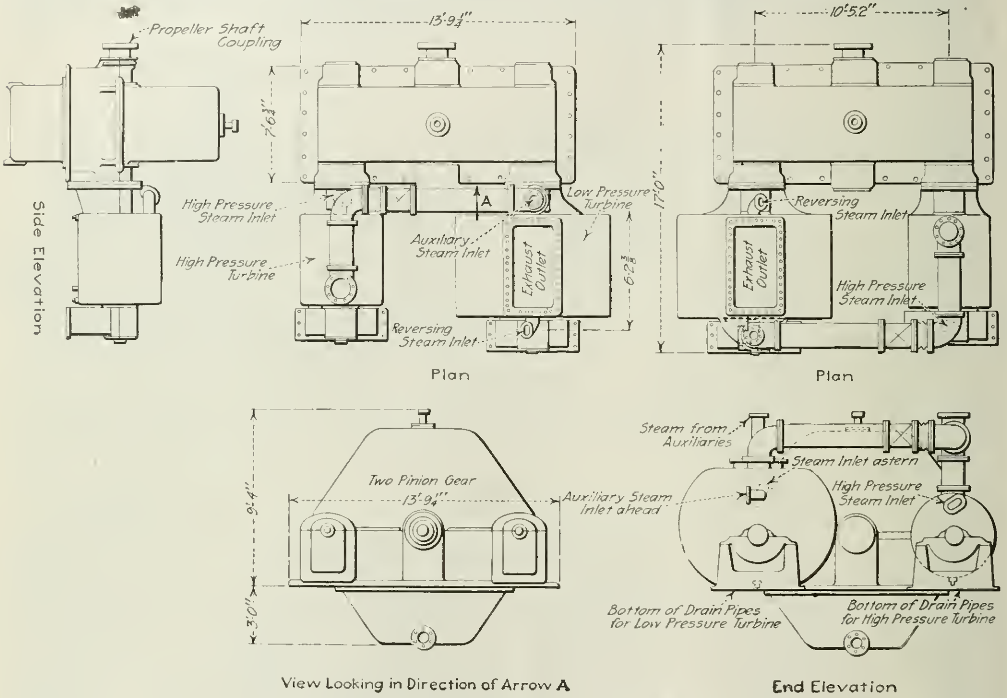


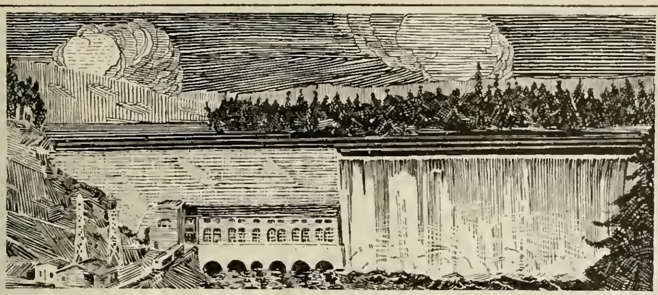
FIG. 4 HIGH AND LOW-PRESSURE TWO-PINION GEARED TURBINE

Three-Pole Switch on Compound D. C. Generator

By R. A. Phillips

When the series-field winding of a compound-wound generator is not energized, it is more guesswork than certainty to closely adjust the generator's voltage with that of the bus prior to paralleling. This is one of the disadvantages of having a three-pole switch on a compound generator—the series field is not energized until after the machine has been connected to the bus, and owing to poor voltage adjustment the machine may immediately take too much load. Another disadvantage of the three-pole switch was discovered one morning when we tried to parallel our second generator.

This machine is the oldest in the plant and is equipped with a three-pole switch. The other machines have three single-pole switches. Every time we closed the machine on the bus, it tripped its circuit-breaker and the breaker on the running unit as well. The third machine was started up, and the first time it was put on the bus the breakers tripped. When the operator opened the negative switch on the third machine, there was no flash, showing that the series fields of the two machines were not in parallel, which indicated at once what the trouble was. The oiler had forgotten to close the equalizer switch of the running machine. Had three separate switches been used on the second machine, we would have discovered this condition at once and saved needless interruptions. It might be added that there are cases where paralleling compound generators with three-pole switches caused considerable variation in the voltage at the time of paralleling.



POP'S WATER-POWER COURSE

By

John S. Carpenter

POP affected a sanctimonious look as he drew with bold strokes on a sheet of paper, while Jimmy moved up close to watch the thing take shape. When he stopped, he had the sketch shown in Fig. 1.

"Jimmy, see them gates I drawed in? S'pose I has to keep the runner a certain diameter an' I wanna make that gate casin' so that I can use two different runners in it, makin' no other changes except increasin' the height if I have to, one runner bein' 100 hp. an' the other 200 hp., how can I turn the trick?"

Jimmy thought a while before he replied: "The only way I can see is that you'd have to open the gates more as you increased the power."

"Yep, I can see that my work ain't been for nothin'. That's it, I gotta open them gates more, an' that's why most high-speed runners has pretty steep angles; the gates has to be opened 'way up to get the water through them. Now, take another look; here is them same gates opened, in one case 30 deg. an' in the other 45 deg. When we come to the problem of buildin' high-speed runners, we jes' take a gate casin' like this an' opens up the gates—the theoretical limit bein' when the gates is plumb radial, supposin' that they don't strike the runner blades or vanes before they are so far open. So much for that.

"A gate casin' may be used with a good many different runners, but each runner must be made to fit the angles of the gate casin' it goes with, the idee bein' that the entrance angles of the runner must conform not only to the angles an' openin' of the gate casin', but also to the speed and power of the runner itself. All of which is the same as sayin' that if you have a given size runner an' you wanna make it run faster than some other that you have in mind, you gotta change the entrance angles so they are shockless at three-quarter load, the load at which most turbines is figgered to have the best efficiency.

"In Fig. 2 you see three runners designed to be used with the same gate casin', but one is made for low speed, low capacity, the next for medium speed, medium capacity, an' the last for high speed, high capacity. As the speed goes up, the angle increases, the present-day angle bein' about 145 deg. The theoretical limit has been guessed at, but nobody knows, 'cause no manufacturer is gonna test a runner that he is pretty darn sure is no account."

"I thought that you told me that all turbine runners are designed with so many per cent. spouting velocity here and so many there?"

Pop's hands dived into his pockets. After he went the rounds two or three times, he dragged out a wrinkled and worn paper which he opened and studied a moment. "Here is a table that our friend the lecturer give me some time ago. In the first column of figgers, which is on the rated diameter as shown in the runner sections in Fig. 3, you have the percentages you're hollerin' about. Also it gives you the angles *a* an' *b* at the runner inlet that has been found by experience to go well together. But don't git the idee that you couldn't make a good runner with slightly different angles, because runner design ain't bound by no hard an' fast rules.

Designation	Per Cent. of Spouting Velocity	*V* Ft. per Sec.	Angle *a* Degrees	Angle *b* Degrees
Low to medium...	64	5.14	15	60
	67	5.38	25	90
Medium to high.	70	5.62	30	100
	73	5.85	32	108
	76	6.10	34	115
High to ultra-high.	79	6.34	36	120
	82	6.58	38	130
	85	6.82	40	140

"Now as to what that *V* means, the spouting velocity for one foot head is 8.02 ft., as I showed before. If you go an' multiply 8.02 by the percentage, you'll git the value of *V* for that particular runner, it bein' nothin' more nor less than the velocity of the runner in feet per second reduced to one foot head, which yer can do by dividin' the velocity of the runner at the given head by the square root of that head. The angles *a* an' *b* is shown on the drawin' of the high-speed runner in Fig. 2."

That much being settled, Jimmy took a squint at Fig. 3 and foundered on the first word he saw. "What does 'type' mean Pop?"

Pop dumped the ashes from his pipe, refilled it and soon had steam up again. "Jimmy, a guy once said they was only about five distinct varieties of chickens, from the plain Plymouth Rock to the Broadway Midnight kind. He woulda been nearer right if he had said runners. We have the low-speed low-capacity type, medium-speed medium-capacity, high-speed high-capacity and ultra-high-speed high-capacity types. It ain't a thing that you can say here is where this type leaves off an' where this one begins, 'cause one type gradually grows into the other. They was a time not so long ago when they would call a runner with a shape like type C a honest-to-goodness high-speed runner, an' designers in them days uster think that they was walkin' on pretty thin ice, not bein' at all sure that the contraption would give the power on account of the exit velocity—or, as it's sometimes called, the discharge velocity—bein' as much as 11 per cent. of the head; meanin' by that, as I told you before, that you takes 11 per cent. of the head an' then finds the velocity due to that head."

"But tell me, Pop, is a runner like type C necessarily a high-speed runner because it's got a shape like that?"

"Well, not necessarily. For instance, I could take a runner somewhere between type B an' C an' design it with a very low discharge velocity in the upper part of the draft tube an' which would give me a big bulge there on account of needin' so much area, an' to all intents an' purposes it would be a high-speed runner until you got to rakin over the figures kinda close. Then you'd see in a jiffy that the high-speed shape was only apparent, to use a high-brow word.

"In order to show the difference in shape, I've drawed five runners in Fig. 3, all for 14 in. in diameter an' for the same r.p.m. In actual practice they would all be different speeds, my object bein' to compare the shapes. Now you'll also mind that the power of them all is different, an' that is the reason the runners is bulged out—to git the area down in the draft tube. You remember the ideal runner we designed in a previous talk? Well, the discharge was straight, about like type A. Makin' the discharge end of the runner vane curved like it is in the higher-speed shapes gives you more area. So far as the figgers go, when the discharge is made curved, the calculations ain't so safe as they is when the discharge is simply a straight line, 'cause it's harder to tell just which way the water may go an' just that little difference is what means that you git the proper amount of power or you don't.

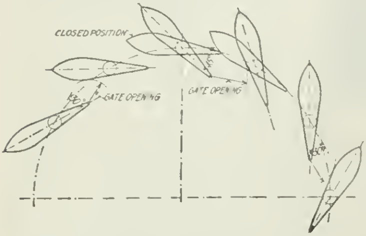


FIG. 1. SHOWING GATES IN OPEN AND CLOSED POSITION

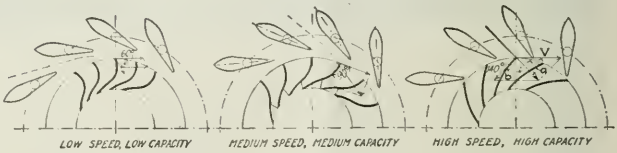


FIG. 2. THREE RUNNERS DESIGNED TO BE USED WITH THE SAME CASING

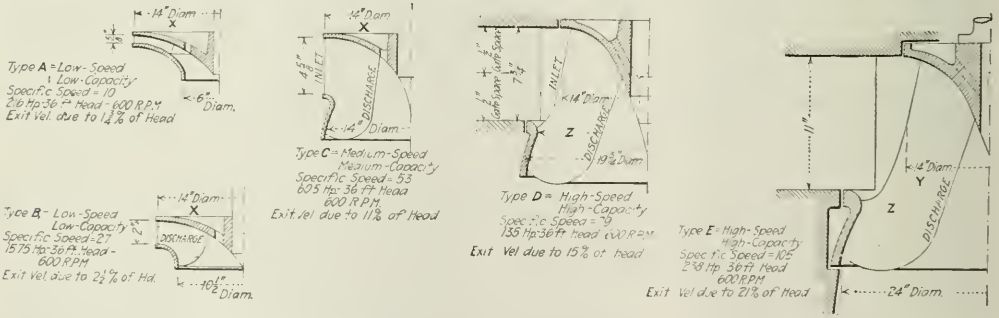


FIG. 3. LOW-SPEED LOW-CAPACITY, MEDIUM-SPEED MEDIUM-CAPACITY, AND HIGH-SPEED HIGH-CAPACITY RUNNERS

"The place for measurin' the diameters is a chip on the shoulders of many turbine designers. On runners of types A, B an' C they is pretty well agreed that you should call *X* the runner size. When it gits to types D an' E, an' which is the way most runners look like today, some argues that you should call *Y* the diameter an' still others says that it must be *Z*. I belong to the last-named gang fer the reason that the diameter *Z* is a better gage for measurin' the water quantity, which is a blood relative to power, power bein' the much-desired thing in this type of runner. Anybody can git mere high speed by jes' reducin' the diameter of the runner, but to git high capacity along with high speed—thats the thing!"

"Your idea don't sound so darn bad. Let's hear more, Pop."

"Since we is fightin' for high capacity, let's rate the runner so we can git a line on it. The highest-speed runner today that is commercially successful has a velocity at *Z* of 68 per cent. of the spoutin' velocity of the total effective head; or, deductin' runner friction, etc., 75 per cent. of that of the net effective head. That leaves only 25 per cent. of the spoutin' velocity due to the net head for producin' reaction at the dicharge."

"It's a hard world, Pop; but tell me, do they have any method of telling by comparison which type of runner or which runner of a bunch is the best for that particular job?"

"Now we're comin' to it!" exclaimed Pop, all smiles.

"Coming to what? The hidden treasure?" echoed the surprised Jimmy.

"Yep! The type characteristic, alias specific speed. The real definition of specific speed is that it is the number of revolutions per minute that a wheel or runner 1 ft. in diameter developing 1 hp. makes under 1 ft. head. Some engineers calls it the type characteristic, an' since it ain't libel an' they ain't no law agin it, they gits away with it. Specific speed means more to me than type characteristic do, but some argues that the word 'speed' tends to confuse r.p.m. with velocity, the only difference bein' that they is second cousins instead of first. I likes the word 'specific', 'cause it carries with it the idee of unity, referrin' the speed to 1 ft. head. The practical definition means that it is the product of the speed in r.p.m. of the runner under 1 ft. head times the square root of the horsepower under 1 ft. head. Fer instance, if we had a runner givin' 50 r.p.m. under 1 ft. head an' also 4 hp., we multiply 50 by 2, which is the square root of 4, an' git 100, the specific speed or the type characteristic. Jes' fer another example showin' how it's done, take a runner givin' 2000 hp. an' 100 r.p.m. under 16 ft. head. We find the specific speed as follows: The r.p.m. bein' proportional to the spoutin' velocity an' the spoutin' velocity as the square root of the head, we divide the r.p.m. by 4, which is the square root of the head, an' git 25 r.p.m. for 1 ft. The power under 1 ft. is found a little different. We gota remember that with a runner which has a constant discharge area, the power is proportional to the velocity of the water flowin' through it as well as the head. That means that we gotta divide the 2000 hp. by 4, the square root of the head, an' also by 16, the head itself. Doin' this is what they calls dividin' by the three-halves power of the head, the square root often bein' called the half-power and the head of course bein' the first power of itself, the two added makin' the three-halves power. So dividin' 2000 by 4 an' then by 16 is the same as dividin' by 64, which gives us 31.3, the power of the runner under 1 ft. head. Now the square root of this 1 ft. head power is 5.6, an' that multiplied by 25, which you will remember was the r.p.m. under 1 ft. head, gives us 140, the specific speed."

"Wouldn't it be nice to have a table of the three-halves powers, Pop?" asked Jimmy.

"I don't see that you needs any more than a table of square roots, an' which you'll find in darn near every handbook worth the name."

"The next time we'll see how the turbines is built, meanin' the construction details an' the mountin's. That about finishes up the subject of tubines, an' then we dooly takes up an' studies the Pelton wheel, alias the impulse wheel an' the tangential wheel, and when we get through you'll know more than you do now."

Getting a Refrigerating Plant Out of a Critical Situation

By J. C. Moran

In the face of increasing load demands the three ammonia compressors could not be made to carry the normal load. The troubleman diagnoses the case and finds, after investigation, that simple remedies will make it unnecessary to install about 100 tons additional capacity, or to operate all three machines together to supply service.

EQUIPMENT in the plant in question consisted of a number of electric generating units which supplied power and light to a little town, the necessary boilers and auxiliary equipment and three refrigerating machines of 50, 75 and 100 tons capacity respectively. These handled a cold-storage plant and two ice tanks.

The load on the cold-storage plant had been increasing gradually until it was impossible to keep the temperatures down and at the same time pull the ice tanks at full capacity. The operators had done everything in their power to get the highest capacity out of the machines. The cylinders had been rebored, new pistons and rings fitted, new valves put in some of the machines and the rest ground in, and the condensers and expansion coils had been given a thorough cleaning both inside and outside; regularly every other day some of the men went over the coils and scraped the frost from them, but the cooler temperatures would persist in remaining higher than they should be for the kind of goods stored.

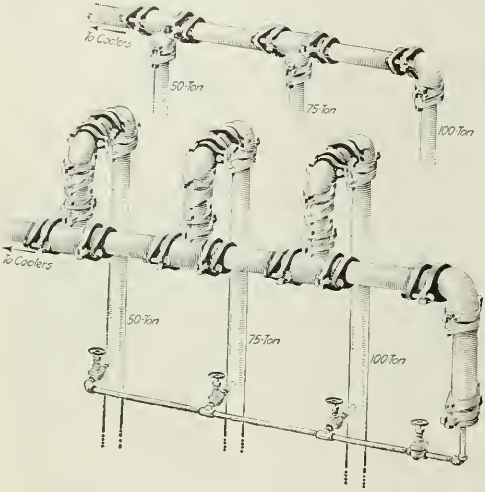
Evidently, there was nothing to do but buy another machine, as they were considering building another story on top of the cold-storage plant and this would require additional refrigerating capacity. Consequently, the chief engineer was asked to make an estimate as to the capacity of machine required and also the additional amount of piping necessary. The writer, a friend of the chief's, was invited to assist him solve the problem. The plant appeared to be in tiptop condition. After having talked over the problem in general, we made a trip through the coolers, estimated the amount of pipe in each, noted from some old blueprints the amount of insulation in each room, and from the quantity of ice pulled in connection with the other data each 24 hours we then set down to figure out the estimated load. Not satisfied with the first results, the total coil surface in each room and ice tanks was taken and the heat transmission estimated. All I could get at the highest was the equivalent of a little over 140 tons, while according to the rated capacity of the machines they should be pulling about 225 tons.

We went back and checked the figures of the pipe surface, room temperatures and insulation over again. The figures were right. We turned our attention to the machines, particularly to the suction pressure, but this was good for the temperatures carried; from the temperatures of the discharge lines of the machines they were all working to the best advantage.

After investigating everything from the basement to the roof, we decided to indicate the compressors. I was getting suspicious of two of the machines, the two smaller units, thinking they were "lying down on the job" because the governors were riding unusually high and the cutoff was short. Suspicions were substantiated when the diagrams were taken. Two of the machines were probably handling not over 30 per cent. of their rated load. Instead of 12 lb. suction pressure, which the gages showed, and which also showed the same on the card from the large machine, these machines indicated a suction pressure in the cylinder of about 10 in. vacuum. Either there must be something wrong with all the suction valves of the two machines or there must be an obstruction in the suction branch to each of the machines on which there was trouble because the machine that was doing most of the work was at the end of the line and in case of obstructions in the main line would have been affected the same as the others.

Without any particular purpose in mind I gave one of the suction stop valves a twist. To my surprise I continued turning until I thought that the threads on the stem must be gone, when the valve finally stopped and would turn no farther. Evidently, the valve had been nearly closed. The same condition was found on the other machine on which trouble was experienced. The large machine that was working properly had its valve wide open.

One of the engineers happened to come around at this time, and I asked him about the valves. To my surprise he said he was well aware of it and that it was impossible to run them otherwise, because they would run ice-cold while the one at the end of the line would burn up the stuffing-box packing as fast as they could put it in. Apparently, he was right. He had no more than got through telling me about it than I began to smell ammonia pretty strong, and upon investigation found it was coming from the stuffing-boxes of the two smaller machines, and that the discharge line from the 50-ton machine, as illustrated in the sketch, was as cold as ice; the discharge from the 75-ton machine was a little warmer, but much too cold for efficient operation.



HOW THE PIPING WAS ARRANGED

The 100-ton machine at the end was just the reverse, however. The stuffing-box was beginning to smoke, and some quick work was necessary to keep it from burning out at once. The discharge line was so hot that it smoked. To bring things back to normal we had to choke off the suction valves again on the 50-ton and 75-ton machines.

The trouble was caused by too much liquid in the suction gas, and this was hard to prevent because it was necessary to work some of the small coils in the low-temperature rooms to their greatest capacity and a little liquid would carry over into the suction line at times with the closest regulation. The result was that with the piping shown in the top view the 50-ton machine got most of this liquid and the 75-ton machine the rest. The 100-ton machine got nothing at all and ran too hot.

By throttling the suction valves of the two machines, the gas was partly superheated and evaporated some of the liquid in the suction gas. Also, this increased the ratio of compression several times, which further tended to heat the gas when it was finally discharged from the machine. It also reduced the capacity of the machine so much that sufficient liquid was carried past them to keep the 100-ton machine cool. This, by the way, is not the first time I have seen the same remedy used for this trouble, and it is always done by men who pride themselves on their *practical* experience. A man thoroughly posted on the principles of ammonia compression would never attempt such a makeshift.

How the Trouble Was Solved

The solution of this trouble was simple. We took the connections for the individual branches to each machine from the top of the main line instead of the bottom, as shown in the lower view. From this it will be seen that we merely applied the principles that even a "dub" knows about steam piping. It seems peculiar that some men can see things as plain as daylight in one case and be blind as a bat on the same problem in another case, simply because it has a different name.

The main line was continued for about four feet past the connection to the 100-ton machine. An elbow with a short piece of pipe with blind flange on the bottom was put on the end of the pipe, as shown at the right. The blind flange was tapped for a ¾-in. pipe, and this was connected to the suction lines as shown.

This allowed the amount of liquid carried to each machine to be closely regulated simply by adjusting the valves according to the temperature of the discharge. After this was done the 75-ton machine was shut down and the load carried with the 50-ton and 100-ton at a considerable reduction in the speed.

After this job was finished the writer was asked for further suggestions as to improvements. It was recommended that about 6000 ft. of pipe be added, to be distributed around the various coolers, particularly two low-temperature freezers, where a temperature of 15 deg. was carried. These rooms were lightly piped for the load and temperature they had to carry; to get results the suction pressure had to be kept low enough to make the increased temperature difference between the boiling ammonia and the room make up for the insufficient piping. This suction pressure was much lower than it was necessary to carry for the rest of the plant if sufficient pipe surface was provided. The result was that the machine capacity was reduced and the power cost increased.

About 3000 ft. of pipe was put in the two freezers, and when this was done it was possible to keep them at the proper temperature with a suction pressure of about 20 lb. This meant an increase in capacity of the machines of about 25 per cent. at the same speed. By speeding up the 100-ton machine to about 75 r.p.m., from 60, at which it had formerly been run, it was easy to handle the whole load with the one machine in the warmest weather. After the new story was built, the load was handled easily, even in the warmest weather, with the 50-ton and 75-ton machines, and the 100-ton unit was shut down. When the weather moderated, the 100-ton unit handled it nicely alone and often the 75-ton machine could handle it.

Any reputable boiler manufacturer can guarantee the efficiency of a boiler if he knows the quality of coal that will be used, in order that the proper ratio of grate and heating surface area can be provided.

The Electrical Study Course—Methods of Obtaining a Three-Phase System

It is shown how a three-phase system can be obtained by the use of three single-phase generators connected in delta or star. Also, how a three-phase system can be obtained from a single generator with three windings on its armature, or with a single generator with only one winding on its armature.

IT WAS found in the preceding lesson that a two-phase system consisted of two single-phase sources of the same frequency and voltage, but differing in phase by 90 deg. Similarly, a three-phase system is one that combines three single-phase sources of the same frequency and voltage, but differs in phase by 120 deg. Such a system could be derived from three similar generators coupled together, the taps of whose windings occupy positions relatively 120 deg. apart, as in Fig. 1, or from a single machine with three windings, Fig. 2. In generator 1, Fig. 1, the taps a_1 b_1 are in a position where the armature generates maximum voltage. In generator 2 the armature is shown turned counter clockwise through an angle of 120 deg. from the maximum position, while the armature of generator 3 is shown turned through an additional 120 deg., which brings it also 120 deg. away from a_1 of machine No. 1. In spacing the taps as shown, each tap a is 120 deg. away from any other tap a, and, similarly, each tap b is 120 deg. from any other tap b, thus making the entire arrangement symmetrical. If the voltages of the three generators are alike, as assumed, they would constitute a three-phase system, of which it would be said that wires AB are one phase, wires CD another phase, and wires EF, a third phase.

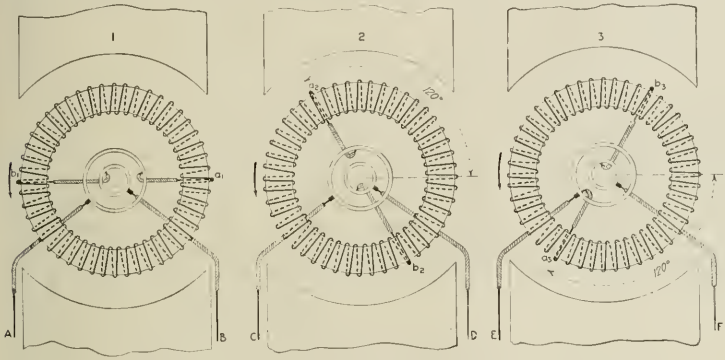


Fig I

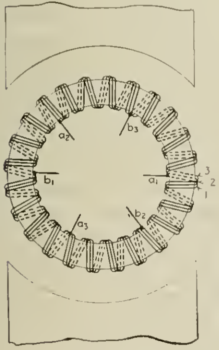


Fig 2

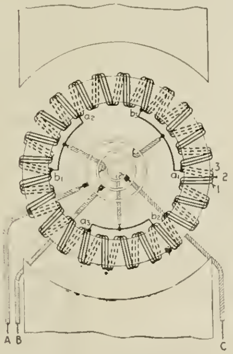


Fig 3

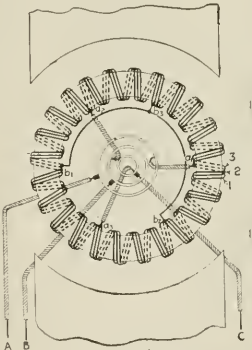


Fig 4

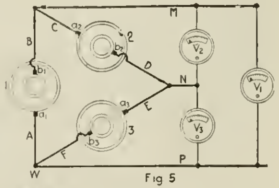
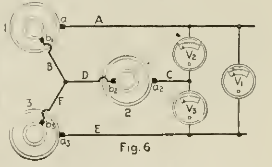


Fig 5



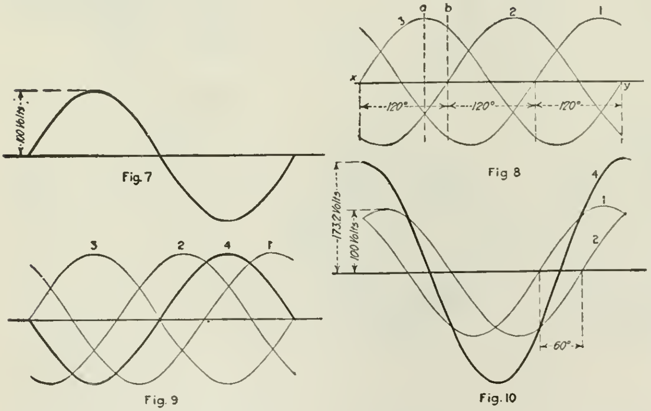
FIGS. 1 TO 6. DIAGRAMS OF DIFFERENT METHODS OF OBTAINING A THREE-PHASE SYSTEM

Fig. 1—Three single-phase generators connected 120 deg. apart. Fig. 2—Three windings on one armature with taps brought out 120 deg. apart. Fig. 3—Three windings on one armature connected in delta. Fig. 4—Three windings on one armature connected in star. Fig. 5—Three single-phase generators connected in delta. Fig. 6—Three single-phase generators connected in star.

Six wires are not usually used for three-phase transmission, which is generally accomplished by the use of three wires only, by connecting three windings on one generator, Fig. 2, either as shown in Fig. 3 or as in Fig. 4. The same thing could be applied with the three generators, Fig. 1, by grouping them as in Figs. 5 and 6; the former of these is shown as the delta connection and the latter as the Y or star connection. Judging by appearance it might be concluded that the arrangement shown in Fig. 5 would cause a short-circuit of the generator. Such, however, is not the case. An examination of the relation between the voltages will show why. Suppose that the connection at W is allowed to remain open and a voltmeter be connected between A and F, it will be found to indicate no voltage. To understand this, let us add the voltage of generator No. 1 to that of No. 2 and then add the voltage of No. 3 to the former and find out what the total voltage between A and F ought to be.

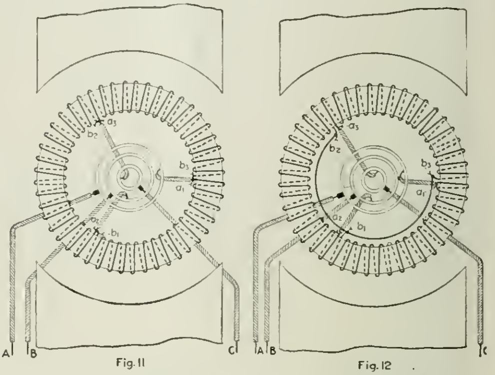
The voltage of each generator can be represented by a sine curve such as that shown in Fig. 7. Assume that the maximum value of this curve is 100 volts as shown. Although the three voltages may be each represented by such a curve, yet, when the three are represented at the same time they must be placed so as to show the phase difference between them. Thus, in Fig. 8 curves 1, 2 and 3 represent the voltages of generators Nos. 1, 2 and 3 respectively. It will be seen that the zero point of the curves are 120 deg. apart, that is, one-third of 360 deg., or one-third of the distance from x to y, which is the distance of a complete cycle. When curves 1 and 2 are added, we get the result indicated by curve 4 in Fig. 9. It will be seen that this curve is exactly like curves 1 and 2, but that it lies midway between them. The voltage represented by curve 4 is what exists between points A and D in Fig. 5. If we now wish to add curve 4 to curve 3, the voltage of generator 3, it will be seen that they are equal and opposite. Consequently, the resultant voltage is zero; that is, the voltages represented by the curves just neutralize each other. Hence, there will be no voltage between A and F and the two terminals may therefore be safely connected together as at W in Fig. 5. The system as illustrated in Fig. 5 will therefore provide three equal voltages 120 deg. apart, one across MN, another across NP and a third across MP. The three voltmeters, V_1, V_2 and V_3 will consequently read alike, each indicating the maximum voltage times 0.707. In this case we assume the maximum voltage to be 100. Therefore, the voltmeters will read, 100 × 0.707 = 70.7 volts.

Another way of looking at this is to consider the instantaneous values of the three voltages. At point a Fig. 8 the voltage of generator No. 3 is at a maximum and that of Nos. 1 and 2 is at half value and in opposition to that of No. 3, consequently the resultant of the three e.m.fs. at this instant is zero. At point b No. 2 is zero and Nos. 1 and 3 are of equal values but in opposite direction, one being above the line xy and the other below, consequently the resultant of the voltages is again zero. This will be found to be true for any instant on the curves, the sum of the instantaneous values above the line xy are equal and opposite to those below.



FIGS. 7 TO 10. CURVES SHOWING RELATION BETWEEN THREE-PHASE VOLTAGES

In the Y connection, Fig. 6, a terminal of each generator is connected to one terminal of the other. In making this connection, like terminals are connected together; that is, either all the a or all the b rings are connected together; in the figure the b rings are so shown. From the diagram it is apparent that the voltage across AC is the resultant of the voltages of generators 1 and 2, that the voltage across CE is the resultant of the voltages of generators 2 and 3 and that across A and E is the resultant of the voltages of generators 1 and 3. The problem then is to determine the value of these resultants. To do so, refer to Fig. 1. If terminal b_1 of generator No. 1 is connected to terminal b_2 of No. 2, the voltages of No. 1 and No. 2 no longer have a 120-deg. relation but only a 60-deg. relation. That is, it makes a difference of 60 deg. whether the voltage of generator No. 2 is added in the direction a_2 b_2 or in the direction b_2 a_2. Since the voltage of No. 2 is 60 deg. ahead of that of No. 1 instead of 120 deg. behind, as in Fig. 1, the sine curve for No. 2 will, so far as its effect on the addition is concerned, have to be shown in the position indicated in Fig. 10, instead of that indicated in Figs. 8 and 9. The resultant will then be expressed by curve 4, Fig. 10.



FIGS. 11 AND 12. THREE-PHASE SYSTEM FROM ONE ARMATURE WINDING

Another way of looking at this is that the connection of No. 2 generator has been reversed relative to No. 1 machine. In the delta connection No. 2 machine, Fig. 5, a_2 is connected to b_1 of No. 1 machine, where in the Y connection, Fig. 6, b_2 of No. 2 machine is connected to b_1 of No. 1 machine, that is, the connection of No. 2 machine in the latter case has been reversed. Therefore if the connection on No. 2 generator has been reversed, its voltage has been reversed relative to that of No. 1. Thus, by reversing curve 2, Fig. 8, that is the part of the curve below the line is put above and the part above placed below, we will get a relation between curves 1 and 2 as shown in Fig. 10, and the combination of these two curves will give curve 4, which, it will be seen, is considerably greater than either 1 or 2. In Fig. 9 combining curves 1 and 2 gave a resultant curve having the same value as 1 and 2; in Fig. 10 the maximum value of the resultant curve is 1.732 times as great as that of 1 or 2. This is due to the voltage having a 60-deg. phase relation in the latter case and a 120-deg. phase relation in the former.

The maximum height of No. 4 curve, Fig. 10, is 1.732 times No. 1 or No. 2. Then if the latter is 100 volts, the former is $1.732 \times 100 = 173.2$ volts. In Fig. 6 voltmeter V_2 will indicate $173.2 \times 0.707 = 122$ volts. Following the same method as in the foregoing, it will be found that the voltage across *CE* in Fig. 6 is equal to resultant of that from generators Nos. 2 and 3. These voltages are 60 deg. apart and consequently their resultant will be 122 volts. In precisely the same manner the voltage between *A* and *E* is found to be 122 volts. We therefore have three electromotive forces each equal to 122 volts.

The system illustrated in Fig. 6 is a true three-phase one, since the three voltmeters V_1, V_2 and V_3 each read 122 volts and the voltages are 120 deg. apart.

What is true of the three single-phase generators connected in delta, Fig. 5 and in star Fig. 6, is also true when three windings are used on the same armature, as in Figs. 3 and 4. If the three windings are connected star, as in Fig. 4, the voltage at the terminals will be 1.732 times as great as when connected delta, Fig. 3. Two of the standard voltages for three-phase alternating-current generators are 6600 and 11,000 volts. One of the reasons for their adoption is that $6600 \times 1.732 =$ 11,000, approximately. That is, if a three-phase alternator is designed to generate 6600 volts when connected delta, the same machine would generate 11,000 volts with its windings connected star.

Another method that can be employed to obtain a 3-phase system is to use a single winding and divide it into three parts, as in Figs. 10 and 11. Such a winding would be used for a delta connection by connecting together b_1 and a_2, b_2 and a_3, and b_3 and a_1, and then bringing out three taps to three rings as in Fig. 11. A star connection can be obtained by connecting all the *b* terminals and bringing out the *a* terminals to the slip rings as in Fig. 11. Or, vice versa, all the *a* terminals could be connected together and the *b* terminals brought to the slip rings. With such a machine three separate and equal voltages could be obtained with the voltage from the star connected winding 1.732 times as great as that from the delta connected winding.

A three-phase generator has three separate windings, each of which generates 2300 volts. What would be the voltage per phase with delta connection? What with Y connection.

If a voltmeter reads 2200 volts when connected across an alternating-current circuit, what is the maximum value of the supply voltage?

Shells of various caliber have proved by experiments to have considerable commercial possibilities. The steel of which they are made is in many cases capable of being rendered glass hard, and milling cutters have been produced which have stood the most exacting tests. After a little manipulation on a lathe, an 18 pounder shell, minus nose and copper rotating band, makes an excellent shafting coupler. The 6-in. shell in the same way becomes a fine flexible coupling. Many other uses of this material have been devised.

Neglected Parts of Water-Tube Boilers

By Warren D. Lewis

Perhaps the most neglected parts of water-tube boilers are the front and rear headers with their respective handhole fittings.

It is usually a hot, dirty job to clean headers and caps, and as for closing up the boiler, this is usually done as quickly as possible, the front and rear doors shut, and the whole thing forgotten until possibly a cap gasket blows out or the regular overhauling and cleaning time arrives. When the doors are opened, everything is usually covered with a white scale which is hard to remove.

Now, this condition makes extra work, which is unnecessary. The time to begin to prevent it is when the boiler is new. Headers are sometimes painted by the boiler manufacturer to prevent rusting, but usually not even this precaution is taken. If at this time the headers were rubbed down with plain flake graphite mixed with a little water as a carrier, and the tube holes, caps and dogs treated the same way, any deposit from a leaky cap could be easily removed with a stiff wire brush.

When closing up the headers it should not be attempted to pull the caps up to their final position. While the boiler is filling with water, leaks should be looked for and corrected even if it is found necessary to empty the boiler again. As the temperature rises the caps should be gone over and tightened, and again when the boiler goes into service, under full steam pressure. If the caps are watched for a day or two for leaks, the doors may then be closed with the assurance that there will be no dirty looking headers a few weeks or months later. Of course it is possible that with an old boiler the preceding method is not the whole solution of the problem, but leaks from caps are usually due to carelessness.

Most boilers are now equipped with inside caps, and here the pressure assists in making the cap tight. To clean the bearing or joint surface of an outside cap is a simple operation, especially with the aid of a resurfacing machine; but cleaning the header for inside caps is an awkward, tiresome job. A poorly cleaned header will usually cause the caps to leak. One way to prevent this is to inspect the header by means of a small mirror held inside, light being supplied by an electric lamp. This will show any dirt on the header and is much more satisfactory than passing the fingers over the surface. For round inside caps there is a simple, inexpensive machine made which will scrape the surface inside the header better and quicker than can be done by hand. I have never heard of a machine to scrape the surfaces of elliptical holes.

The selection and use of handhole gaskets is an important part of this work. There are several kinds, the most common ones being either of asbestos rubber or semimetallic, these last being composed usually of a thin copper or soft-steel ring with an asbestos core. I prefer the semimetallic gasket as it usually makes less work in cleaning headers and caps when removed. If the asbestos or rubber gaskets are rubbed well with graphite, they are not likely to bake on the metal and cause trouble when removed. Notwithstanding the small additional cost of the semimetallic gasket, the labor saved makes it, I believe, the cheapest in the long run.

Improved Green Steam-Jet Ash Conveyor

Some of the more prominent features of the steam-jet ash conveyor made by the Green Engineering Co., of East Chicago, Ind., are shown in the accompanying illustrations. In the new system an improvement is the provision of roller supports, expansion joints and fixed anchorage between such expansion joints. The metal being extremely hard is necessarily brittle and subject to breakage. All joints are ground and a thin tar-paper gasket permits an air-tight joint to be made at the time of the installation and experience indicates that the joint will remain tight after the system has been in operation.

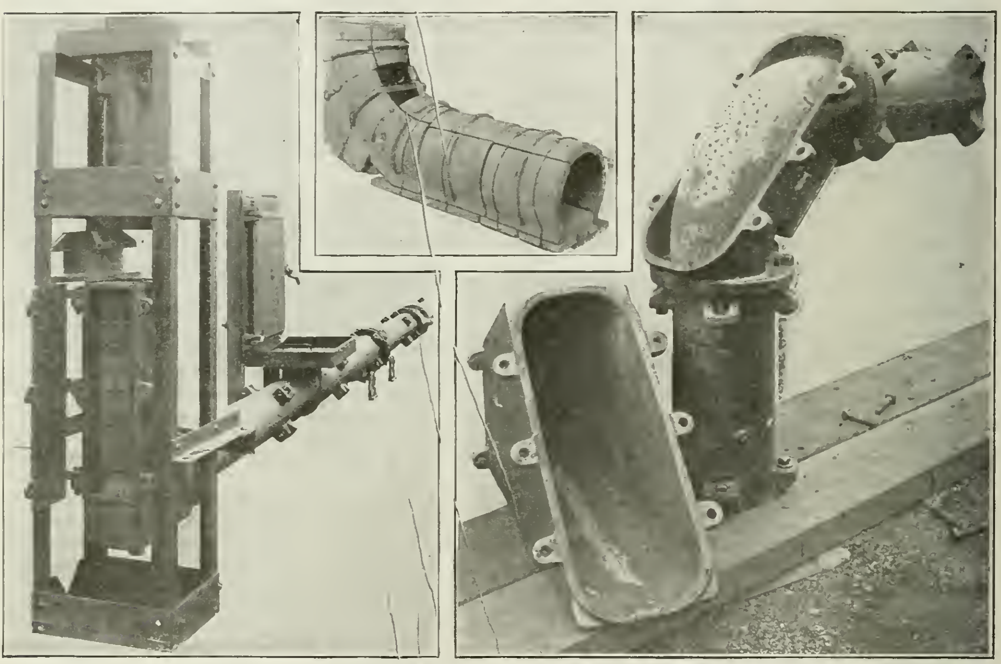
The new steam-jet elbow is of square turn construction and replaces the former long-sweep steam-jet elbow. It is lined throughout with small hard-iron inserts about 6 in. long. The elbow with its liners rises 3 ft. above the steam jet. The division of the wearing back provides for renewal at any point where extreme wear may occur. A hinged back cover gives access to the elbow for regular inspection and renewals when necessary. A substantial structural steel frame supports the elbow and the vertical pipe run.

As a further safeguard for minimum maintenance cost a 2-ft. pipe section is connected above the elbow. If heavy wear does extend beyond the elbow it will require the renewal of only the 2-ft. section instead of a long section that is worn at but one end. This section may be turned through four 90-deg. positions, reversed and again thus turned before it must be renewed.

Where no steam jet is necessary an "ash pack" long-sweep elbow is used. In this case the point of wear is not influenced by the steam jet and invariably occurs at the back of the fitting. A substantial back is provided to take the initial wear from the ash and this is surrounded by a box casing packed with ash at the time of installation. Eventually the ash in the conveyor drills a hole in the wearing back and thereafter it is projected against the ash pack between the casing and the back. The wear is then limited to ash upon ash.

In delivering the ash to the storage tank much the same principle is employed. On top of the storage tank is the usual tank box which the conveyor pipe enters horizontally. On the opposite side of the box is a thimble-shaped receptacle filled with ash to take the impact of the conveyor discharge. It replaces the hard-iron baffle formerly used. Below the box is a horizontal baffle to interrupt the flow of ash and allow it to settle gently into the tank.

In the pipe line the intakes and their covers are provided with ground joints to prevent air leakage at these points. All overhead pipe runs, as well as the elbows, are hung from a permanent structural steel frame so that renewals can be effected without tearing down the entire line.



STEAM-JET ELBOW WITH SUPPORTING FRAMEWORK, LINING OF STEAM-JET ELBOW AND LONG-RADIUS ELBOW WITH BOX CASING REMOVED

Failure of the pine cap of a timber trestle erected for falsework on bridge construction led to the testing, by the Bureau of Standards, of the crushing strength of this material perpendicular to the grain. A 12 x 12-in. block was loaded in the large testing machine by being placed crosswise between two blocks of the same size under a load of 200,000 lb. The thickness of the cross-block was reduced from 12 to 6 in. at a pressure of about 1380 lb. per square inch.

EDITORIALS

Doctor Succeeds Dentist as Chicago's Smoke Inspector

FOUR years ago, shortly after the change in administration, a dentist was appointed as chief smoke inspector of the City of Chicago. Such a selection was commonly regarded at the time as political, for the appointee did not have the mechanical qualifications called for by the ordinance. It was claimed that a good executive could fill successfully this position and that detail knowledge of combustion and mechanical engineering in general was not essential. Evidence from the last four years does not confirm these contentions.

In 1915 Chicago's smoke department held an enviable reputation. From all sections of the country came inquiries as to the methods employed, and it was generally conceded that the Chicago department in successful smoke abatement was the pioneer and the leading authority of the nation. From a position second only to Pittsburgh in its smokiest days, Chicago had become a comparatively clean city. The plan of coöperation with the owner and education of the plant operator, rather than an arbitrary imposition of fines on violators of the smoke ordinance, had been eminently successful. These results had been secured by an able corps of engineers and inspectors headed by men of mechanical training who were professionally superior to their subordinates and were competent to direct the work and pass judgment on the results obtained. Publicity in the daily press was used to advantage, and a smoke abatement commission of representative business men rendered invaluable assistance. The department had been maintained free from politics, a leading reason for its success.

From the year 1915 the department has been on the down grade. Its work gradually became less effective, until now Chicago is back to the old days of dirt and smoke. The conditions that existed last winter have, it is generally conceded, never been surpassed in the history of the city.

In 1915 the department had a personnel of thirty and an appropriation of about $42,000. Men were dropped gradually and the appropriation became less each year. By 1918 it had been reduced to $26,000 and there were only thirteen employees. The admirable work of the smoke abatement commission was not appreciated by the mayor, as he failed to reappoint a similar body. Fines were imposed less frequently, and violations for the most part were being overlooked. War conditions with the change in the coal made matters worse, so that the department, already inadequate, was completely swamped and its efforts had little effect on the deplorable conditions which were then existing.

When the same administration returned to office in April of the present year, it was hoped that some attention would be paid to the numerous complaints that had been made and that the department would be restored to its former state of efficiency. The chief smoke inspector was promoted to the more lucrative position of commissioner of public service, and the department was allowed to drift along without a cabinet head until appropriations for the year 1919 came up for consideration in June and July. At this time an appropriation was made for the department as the Bureau of Smoke Inspection of the Department of Health, and no provision was made for the salary of the chief smoke inspector. Contrary to usual procedure these transactions took place before enabling legislation had been passed by the council to permit the transfer of the authority of an independent department to the Board of Health.

In the meantime a subcommittee of three of the Committee on Efficiency and Rehabilitation met to consider the proposed ordinance for placing the smoke department in the ventilating division of the sanitary bureau of the Health Department. Dr. Robertson, health commissioner, would thereby be the nominal head of the smoke department, and being present at the meeting he proposed to attack the problem from a medical standpoint, treating the smoke nuisance as dangerous to health and summarily abating it if necessary, regardless of conditions in the plant. Violators of the smoke ordinance were to be fined heavily if they persisted in endangering the health of the community by producing visible smoke. He promised to use all avenues of publicity open to the health department and conduct an active campaign to create public sentiment against the smoke nuisance. There has been recent evidence of this policy in the daily press. For the technical direction of the department his authority would be transferred to Dr. Vernon E. Hill, a doctor of medicine and an engineer who for a number of years has conducted with credit the ventilating division of the Health Department. The ventilating inspectors were to coöperate with the smoke department and help eke out the limited appropriation that had been made for the current year.

Representatives of the Western Society of Engineers and of the City Club and other engineers were present to protest against the subordination of the smoke department. The work was large enough, they urged, and of such importance as to warrant an independent organization by which full attention could be given to the work in hand and there would be no diversity of interests. In years past the proposed plan of making the smoke bureau an adjunct of the health department had never been successful. An engineer-executive was considered essential, as he must be capable of directing the work intelligently and passing on results obtained.

With a doctor at the head of the department it was feared that the viewpoint would be medical rather than from the engineering standpoint of efficiency and economical operation of the plant. It was recognized that dense smoke was a serious menace to health, but it was only one of the objections to the smoke nuisance. Attacking the problem in an engineering way would utomatically eliminate the danger to health, the injury o property and other nuisances and, of prime importance financially, improve plant economy. Only an engineer-executive as chief smoke inspector could successfully cover all angles of the problem, and it was the view of the engineers that the smoke-abatement commission should be reëstablished. For these reasons they entered a decided protest against the proposed action.

With two members of the subcommittee present, and Dr. Robertson, who was insistent upon the change, it was decided that under the conditions the ordinance for the transfer of the smoke department should be passed and the matter should be presented to the committee as a whole. The main committee met on July 28, but, owing to lack of a quorum, no action was taken. The chairman of the subcommittee, however, assured the engineers who were present that no further action could be taken until the first meeting of the city council in November. Apparently he had not taken into account possible action by the mayor and that the proceeding had the earmarks of a prearranged plan.

During the week of August 25 it was announced in the daily press that Dr. Robertson, by an executive order of the mayor, had been appointed chief smoke inspector. With no salary now attached to the office, it is difficult to see any ulterior motive. Notoriety to be gained from a big publicity campaign might be a factor, but if anyone can succeed in ending the smudge that has blackened Chicago skies, he is entitled to all the glory there is in it. The council has yet to confirm the appointment and pass the enabling legislation to transfer the smoke department. They may consider themselves overridden and object to the high-handed methods that have been adopted.

It is still a number of weeks before November and the first meeting of the council. Engineers of Chicago have time to prepare their case, and it would seem that concentrated efforts for the good of the profession and for the health and welfare of Chicago citizens should be in order. There is no doubt that the plan for smoke abatement, as outlined by the engineers before the subcommittee, is the better of the two. It is comprehensive, covers all angles of the problem and in Chicago itself has been tried previously with eminent success. The proposed plan has also been tried, but has always been a flat failure.

Make it Easy To Be Right

THE engineer of a large electrical system gives as one of the elements of his successful handling of large power-plant problems his practice of making it easy to do the right thing.

Human effort, as well as mechanical force and electricity, follows the line of least resistance. If one makes it easier for his help to do things as he wants them done than to get by with them in any other way, they will be done as he wants them and without any pushing or driving or bawling out. So far as it lies in your power, make the way that leads to the greatest efficiency the easiest and most attractive way.

There are many hot, arduous and disagreeable tasks about a power plant. Sustained efficiency, even perhaps dependable operation, depends upon their being done, and done right. A boiler will be more conscientiously cleaned and inspected if it and its setting have been allowed to cool off before the men are made to enter them. The cleaning of the soot from the heating surfaces should be done at regular times or after a certain amount of service, determined by observation of the effect of such cleaning. The hand-cleaning operation is one that the average boiler-room help will shirk whenever possible and slight when they have to go through the motions. The modern method of blowers fixed in the setting, requiring but a few moments of operation at more or less frequent intervals, will keep the surfaces clean, enable them to absorb heat that would otherwise go to the stack, and is done at the expense of little if any effort on the part of the man in charge.

The cleaning of condenser tubes is a dirty, disagreeable job that the men will let go as long as possible. The engineer that we are quoting has a method of cleaning them with air-propelled plugs, which reduces the operation to fun and keeps the final pressure for his turbines at the lowest possible average level.

Even in the small plant much can be done by intelligent design, foresight and consideration to make the task of the man in charge easier and thus to insure its being better done. A change in the method of handling the coal and ashes, provision for adequate ventilation and a few little matters of this sort would often give a plant the pick of help and enable it to get better service from them.

"A horse! a horse! my kingdom for a horse!" cried King Richard III.

"O for a synchronous motor!" sighed the central-station manager who had let his system become surfeited with small partly loaded induction motors and transformers of such low aggregate power factor that he had to run two alternators instead of one in order to hold up the voltage.

The war taught Europe an object lesson in refrigeration. If it had not been for the tons of food stored in American warehouses, in Chicago and on the Atlantic seaboard and immediately available, the Allies might have lost the war. Because of this and the great warehouse built by our army in France, Europe has appreciated the value to her of refrigeration.

Engineering Council has requested President Wilson to fill the next vacancy on the Interstate Commerce Commission by the appointment of an engineer. The outcome will be taken as an index to the probable success of the present agitation for greater participation of engineers in public affairs.

Don't covet the boss's job until you are sure you would be safe in having it. You may misjudge the boss. If you could view yourself as the workman from the viewpoint of the boss, conscience might force you to fire yourself as a workman.

The man who tells the chief that he "can't" do something, either has a lot to learn about the business or else he thinks the chief is "kidding" him, in which case he will be better off when he gets another job.

What your plant needs most is your coöperation. It's not the ball players but the team that wins the pennant.

Correspondence

An Adding Slide Rule

In nearly every case college professors, mathematicians and practical engineers will be amused at the suggestion of an adding slide rule, but the device is so simple that any ordinary person can understand its operation. We all know that the fundamental structure of a slide rule consists of a movable scale and a stationary scale. Suppose the movable scale consists of ten equal spaces (Fig. 1) say 1 in. long, which are in turn subdivided into ten equal spaces. A further subdivision may be made as shown in Fig. 3, but for simplicity start with Fig. 1. Number the movable scale 0, 1, 2, 3, etc. (Fig. 1) and make the stationary scale exactly the same, except that the numbering be reversed—that is from left to right instead of from right to left. It is not necessary to reverse the scales, but for various reasons it is better to do so.

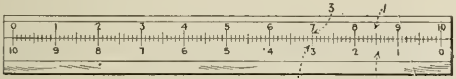


FIG. 1

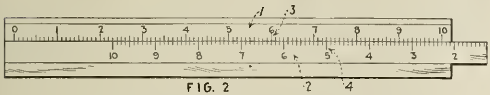


FIG. 2

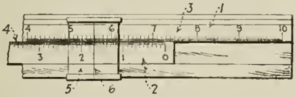


FIG. 3

FIGS. 1, 2 AND 3. SOME SETTINGS OF THE ADDING SLIDE RULE

Suppose we wish to add 4 and 5. Take 4 on one scale (Fig. 1) and 5 on the other scale and place them in alignment. The result would be read on the stationary scale at the index 0, and is 9. Now suppose we wish to add 75 and 48. The numbers are placed in alignment as in the previous case, but this time the result must be read opposite the index 10 which appears to be 23. However, the sum of 48 and 75 is 123 Therefore, it is obvious that a figure one must be placed before the apparent result. In other words, every time a reading is made at the index 10 a figure one must be placed before the result shown on the rule, but, when a reading is made at the index 0, this is unnecessary.

By the use of the runner the sum of two numbers may be held so that another number may be added, and this process may be repeated indefinitely. In adding a long column of numbers, it is only necessary for the operator to set the numbers properly on the rule, as indicated, and count the number of times a reading is made at the index 10. Then the number counted is placed before the reading of the slide rule as a coefficient.

The process of subtraction is simply the reverse of addition. Suppose 172 is to be subtracted from 728 (Fig. 3). The index 0 is placed opposite 728 on the stationary scale, and the runner is brought to 172 on the movable scale. The result, 556, is read on the stationary scale opposite the runner.

With the scales calibrated to fiftieths or hundredths, it is possible to add columns of six or more digits, accomplished in the following manner. Suppose that the following example in addition is proposed:

654,329
761,846
977,762

2,393,937

the sum of which is as given.

To add the numbers on the slide rule, they are added first in columns of three figures, thus:

654	329
761	846
977	762
2,392	1,937

the sum of each column being obtained separately. Then, the last figure in the first column and the first figure in the last column are added in this manner:

2,392
1,937

2,393,937

If the sum of the first figure in the last column and the last figure in the first column should be greater than 9, the first figure in the last column must be added to the last two figures of the first column as shown in the example following:

594,686	594	686
352,843	352	843
793,925	793	925
1,741,454	1,739	2,454

1,739
2,454

39 + 2 = 41

So the result is 1,741,454. In this manner figures of any number of places may be added without mental calculation, it being only necessary to set down the slide-rule readings as shown in the foregoing examples.

Akron, Ohio. A. B. SOLOMON.

Alignment Charts for Finding the Dimensions and Volumes of Bumped Heads

In *Power* for June 17, 1919, on page 927, at the top of the second column, there appears the statement. "The larger value is what the mathematician would term an imaginary quantity, which for practical purposes has no significance." This statement is not correct, and should be changed to read as follows: "The larger value satisfies the mathematical conditions of the equation, but does not satisfy the physical conditions of the problem, and hence has no significance for practical purposes."

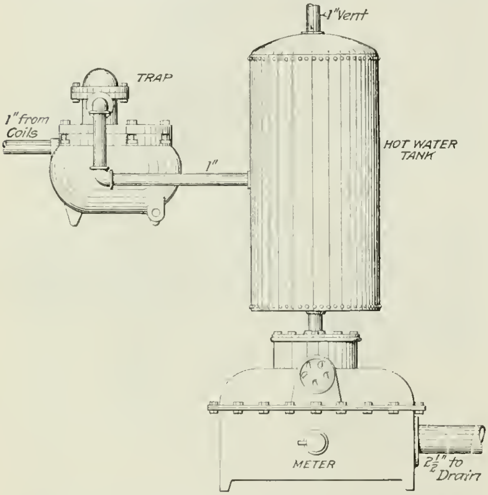
The larger value in question is in no sense an imaginary quantity, as was incorrectly stated.

Detroit, Mich. C. H. BERRY.

Metered the Condensation

In computing the amount of steam used by several of the tenants in the plant I was operating, I would at intervals open the return line and put a barrel on a set of scales under it, and by timing the flow and weighing it I figured the amount of steam condensed per hour. Multiplying this by the number of working hours, I got the approximate amount of steam for which to charge. In spite of the fact that I tried my best to weigh the condensation under average normal conditions, there was constant bickering and dispute about the amount charged.

Looking into the steam-flow meter data, I found that the lines were too small and the expense too great to warrant their use. With the idea of some day finding a satisfactory solution to the problem and always on the lookout for it, I finally found it in the shape of a condensation meter. The illustration shows the method I used in installing several of these meters with highly satisfactory results to all concerned, as I never had a question raised as to their accuracy after they were installed. The steam was used in pipe coils for heating and drying in manufacturing processes and was trapped and the condensation was discharged into the sewer, being too far away from the plant to warrant bringing the returns back.



ARRANGEMENT FOR METERING CONDENSATE

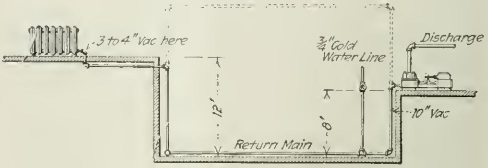
The traps were of the bucket type, and as the meters are of a gravity flow, nonpressure type, I piped the discharge of the trap to a 12 x 24-in. expansion tank (the kind used in house hot-water heating systems) placing it above the meter, the water flowing from the tank to the meter by gravity. From the top of the expansion tank I piped a vent line running up about twenty feet and extending outdoors. At the discharge of the trap this line would relieve all pressure and yet not allow the condensation to escape.

The water flowing through the meter into the drain was recorded in pounds on the dials of the meter and was read monthly, the same as gas or electric meters are read. A. A. WAINRIGHT.

Philadelphia, Penn.

Heating-System Problem

Commenting on the heating-system problem of L. B. Shields, on page 867 of the June 3 issue, I would suggest that the system shown in his Fig. 1 could be improved by installing a connection at the elbow where the pipe dropped twelve feet and carrying it up to allow the necessary clearance and then over and down to the pump suction to avoid the trap, as shown by the dotted lines, thus allowing the pump to draw the air and vapor through this pipe and the water through the lower one, as shown herewith.



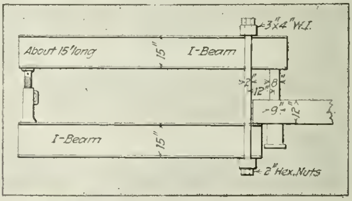
DOTTED LINE SHOWS SUGGESTED PIPING CHANGE

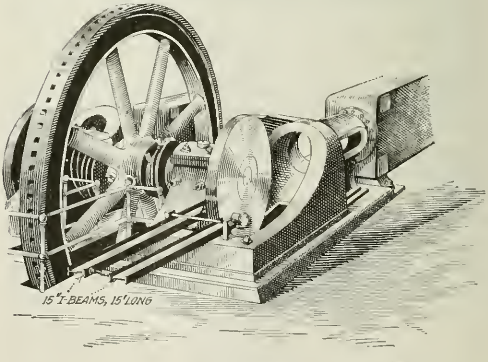
I believe this system would then work satisfactorily.

Brooklyn, N. Y W. T. MEINZER.

Rig for Removing a Crankpin

An engine crankpin 9 in. in diameter and 12 in. long worked loose, but a 400-lb. battering ram had no effect on it in so far as knocking it out was concerned. It was easily removed, however, with the application of the rig shown in the illustration. After its removal the old pin was built up with a welder and turned down to size.





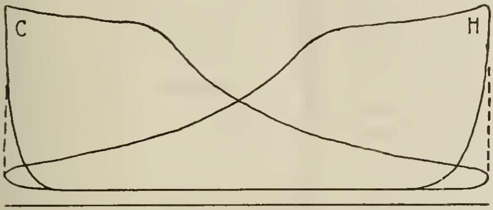
RIG FOR REMOVING CRANKPIN FROM AN ENGINE

After heating the disk red hot with a coke fire, the pin was forced back in place. It has since been running satisfactorily for four or five months.

Norwood, Ohio. A. C. ROCKWELL.

Engine Crosshead Pounds

On page 827 of the May 27 issue of *Power*, E. Hollis shows an indicator diagram taken from his engine and says that the crosshead pounds. I believe the pound is due to lack of compression. The diagram shown herewith was taken from a 26 x 48-in. Corliss engine, running at 74 r.p.m., boiler pressure 85 lb., 50 spring used. This engine runs quietly, but if I try to cut down the compression, as shown by the dotted lines, it pounds. Therefore, I think some compression would help Mr. Hollis.



ENGINE POUNDS WITH COMPRESSION AS SHOWN BY DOTTED LINES

J. C. KAHL.

Columbus, Ohio.

Why Does One Seam Groove More Than Another?

In the July 8 issue of *Power*, page 75, A. Bennett shows two types of lap-riveted joints, one of which rarely if ever shows signs of grooving, whereas with the other type grooving is of frequent occurrence.

The shelf effect of joint *B* collects more or less moisture when the boiler is out of service and empty. This moisture generally being the result of condensation of some slight steam leak is practically chemically pure and a solvent, the result being that some slight corrosion starts which acts as an aid to cause grooving when the boiler is in regular service. In the other type of joint construction the shelf effect is on the outside of the boiler, and any moisture will run to the bottom of shell.

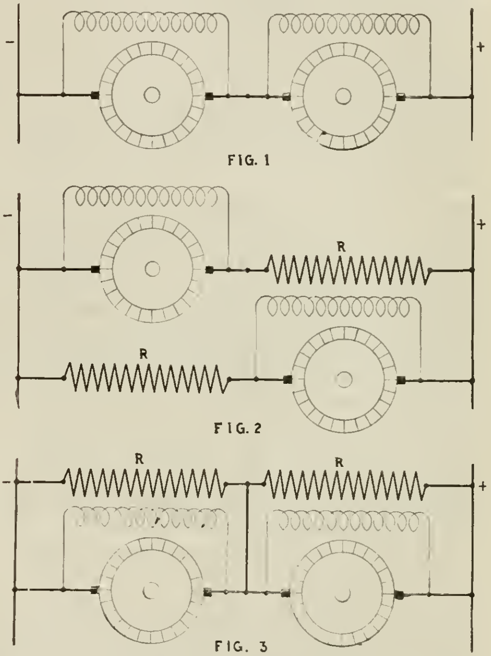
Still another cause of grooving might be due to the working of the joint caused by the expansion or contraction of the metal or by the alternate pressure conditions when the movement at the upper edge of the joint *B* would be greater by reason of its being closer to the horizontal center of the boiler, assuming, of course, that the greatest movement of the shell due to these causes is at the center.

JOHN F. HURST.

Louisville, Ky.

Operating 125-Volt Motors on a 250-Volt Circuit

In a factory it was necessary recently to change the location of a machine used for spinning purposes. The machine was operated by two small 125-volt direct-current motors, connected to a 125- to 250-volt, three-wire system. The nature of the work was such that the motors operated simultaneously. In the new location of the machine a temporary wiring had been installed consisting of the 250-volt mains only. In order to prevent delay in the operation of the machine it was necessary to run the motors from the 250-volt circuit. They were connected in series across the circuit as shown in Fig. 1. When load was applied to the machine one of the motors would slow down and stop, causing the voltage of the other motor to increase to approximately 250 volts, resulting in excessive speed and heating of the motor. The connections were changed as shown in Fig. 2, in which a resistance *R* was used in series with each motor. The resistance was adjusted so that at full load the voltage across the motors would be just 125 volts. This proved objectionable, inasmuch as, when the load was taken off the machine, the voltage would increase to about 220 volts owing to the reduced drop across the resistance boxes. The connections were changed for the third time as indicated in Fig. 3. The two resistances across the line formed an artificial neutral. The motors operated properly this time, the voltage remaining constant at all degrees of load. The resistances were of course removed when the permanent wiring with the neutral brought out, was installed.



FIGS. 1 TO 3. SCHEMATIC DIAGRAMS OF MOTOR AND RESISTANCE CONNECTIONS

Milwaukee, Wis. HOWARD D. MATTHEWS.

Why the Atmospheric Line?

Referring to the indicator diagrams submitted by M. J. Iles in the Aug. 12 issue of Power, page 269, I think he will locate his difficulty in getting the proper atmospheric line in his three-way cock. By taking this off I think he will find that the passage is choked when the handle is at either of the extreme points.

Corry, Penn.

W. L. TRILL,
Trill Indicator Co.

Circulation in Water-tube Boilers

After reading the article in the June 3 issue of *Power*, page 855, by A. Bement, I wish to state that his ideas of the construction of both the furnace and the baffle plate in the steam drum are against the natural philosophy of boiler operation to produce the highest boiler efficiency and to obtain dry steam.

The horizontal and vertical baffle, as shown in his Fig. 2, applies all the furnace heat to the rear end of the tubes. The heat is deflected against the rear water-leg, and this forms a center of equilibrium of the water circulation, and from personal experiences, I find that the circulation is reversed and the water flows backward instead of forward.

As an illustration, assume that the distance from the water line in the drum to the bottom of the rear water-leg is 6 ft. and that the distance from the water line to the bottom of the front water-leg is 4 ft. 6 in. This allows a pitch of 18 in. to the tubes. Then suppose that the tubes are 16 ft. long, and adding this 16 ft. to the 4 ft. 6 in. gives about 20 ft. from the bottom of the rear water-leg to the water line just above the front water-leg. The distance from the bottom of the rear water-leg to the water line directly above it is 6 feet.

According to Mr. Bement's drawing, the furnace heat is applied to the rear of the tubes and to the rear water-leg. Naturally, the water will flow in the direction of the least resistance. This will be up through the rear water-leg into the drum. Applying the heat to the rear is the cause of retarding the circulation of the water in the right direction. Before the water can flow in either direction (because of the heat being applied to the center of equilibrium) a steam pocket must be formed to overbalance the pressure of the water in the drum. This, I find, is the cause of many burnt and blistered tubes. The furnace construction, as shown in Mr. Bement's drawings, also forms a soot and cinder pocket between the rear vertical baffle and the front water-leg, which prevents the heat units from being applied to the tubes.

I also find that an objection is made against a front vertical baffle, where the furnace heat is applied to the front end of the tubes passing in an upward direction, then downward and then upward again at the rear end, because of the smoke produced. In answer to this claim, I will state that, with the proper furnace construction under a vertically baffled boiler, it will produce less smoke than with a horizontal baffle and a higher steam-generating efficiency. The heat should be applied to the nearest point of release of the steam generated, which gives the least resistance of the upflowing mixture of steam and water and creates a rapid circulation, which is the main factor of steam-generating efficiency, and the prevention of burnt and blistered tubes.

In regard to the baffle or deflecting plate, as shown in the front end of the steam drum, it is not the right construction to obtain dry steam. The commotional contact of the upflowing mixture of water and steam with the main body of water in the drum will create a mixture of water with the outflowing steam, which is caused by having this deflecting plate in the wrong position.

In conclusion I wish to state that this baffle plate is a partial infringement upon my patented inventions.

Chicago, Ill. JOHN G. BROMAN, SR.

Superheated Steam—Why Not?

Referring to the editorial regarding superheated steam, in the July 1 issue, I wish to say that I have a fairly representative plant consisting of water-tube boilers carrying 160 lb. pressure, and superheating around 100 to 125 deg. in ordinary practice. I also have one 750-hp. cross-compound Corliss condensing engine driving a two-stage air compressor. This engine was designed for 125 lb., saturated steam, and trouble was anticipated in using the valves with superheated steam, but it did not materialize, as we experimented until a cylinder oil was obtained that would stand up under the service. Since that time no trouble has occurred.

A 450-hp. Unaflow engine was also designed for 125 lb. gage pressure and saturated steam. We had to do some fitting on this engine in order to operate with superheated steam. The first piston supplied with the engine wore down over $\frac{3}{16}$ in. the first year of running, so we put in a new one with a tail-rod and guide to help carry the weight. I do not know whether this will cure the trouble or not.

I also have a twin-tandem compound pump designed for 100 lb. saturated steam. These three engines operate practically continuously. Although this pump has been stopped an aggregate of but 36 hours in four years, it has given no trouble due to wear or because of faulty lubrication and has had only one ring of packing inserted in the stuffing-box in that time. The Unaflow engine, driving a direct-connected alternator, runs practically continuously, as does the air compresser.

For the first two years we examined the valves on these engines every two weeks and gaged the lubrication accordingly; since then they have been examined about every six months. A little trouble was encountered at the start, on account of using too light an oil, until we finally got a specially compounded oil to suit our temperature and moisture conditions. Right here I wish to say that superheated steam does not necessarily mean dry steam; I have considerable moisture in the steam, and it is not the result of condensation.

Besides the foregoing equipment, there is an old straight-line compressor with slide valve and an old slide-valve cross-compound two-stage compressor. These are used only as an emergency set. They give considerable trouble with regard to both packing and lubrication, but are not used enough to determine whether the trouble can be overcome or not.

In summing up, our experience with superheated steam in general has been that Corliss valves give very little trouble if properly fitted and mechanically lubricated. Hydrostatic lubricators are not suitable, and the oil must be properly compounded for temperature and moisture and introduced as close to the points of lubrication as possible, using a multifeed lubricator. Slide valves are not suited to superheat unless designed as light as possible and special oil grooves used to retain the oil. Engines should have deep stuffing-boxes, and metallic packing should be used where possible. I believe that the poppet-valve engine is the logical engine for superheated steam, but it is not necessarily the only one.

Of course results may be different with higher pressures and temperature, but these are my experiences with 150 lb. pressure and 125 deg. superheat.

Ringwood Manor, N. J. ALLAN A. BLANCHARD.

Inquiries of General Interest

Analyzer in Absorption System—What is the analyzer used in the absorption system of refrigeration and what are its functions? H. E. A.

The analyzer is a separator, consisting of a shell with trays or basins one under the other inside. The strong liquor from the liquid pump comes into the top of the shell and it falls on the boiling liquid below, the vapor passing upward. This vapor, which is strong, after leaving the analyzer passes through a rectifier on its way to the condenser. The rectifier aims to extract the last bit of moisture in the gas. The function of the analyzer, therefore, is to separate the ammonia gas from the water which it took up in the generator.

Ball Versus Disk Check Valves—What are the relative merits of ball and of disk check valves? H. D. Y.

The principal advantages of ball check valves are simplicity and compactness and durability for situations where leakage is not of serious importance. For a ball check to remain tight with use, the ball must continue in the form of a perfect sphere and the wear of the seat from pounding must shape the seat to the radius of the ball. The seat may continue round, but unless its surface conforms to the spherical form of the ball, contact between the valve and seat is reduced to a line and there is no breadth of seal against leakage. To obtain a good bearing surface for the seat and correct spherical form of ball requires a high order of mechanical skill. Disk valves tend to conform to their seats from use, they are readily repaired in place and therefore are preferable for situations where check valves must be tight and are accessible for repairs.

Fall of Potential Method of Measuring Resistance—In a well-known book it is stated that a known resistance and voltmeter are required to make electrical resistance measurements by the "Fall of Potential Method." While talking with one who is an authority on the subject, I was told that a voltmeter and an ammeter are required to measure ohmic resistance of electric circuits by the "Fall of Potential Method." Which method is the "Fall of Potential Method"? M. W. K.

Your question is one that is open to discussion. Although certain authors of books dealing with the subject use a voltmeter and a known resistance to measure the ohmic value of an unknown resistance and refer to it as the "Fall of Potential Method," in one of the electrical engineers' handbooks the statement is made, "The fall of potential method consists simply of noting the voltage drop with a known current flowing through the resistance, and calculating the resistance from Ohm's law $R = \frac{E}{I}$." Since the volts drop is used in both cases, it is apparent that both schemes are "Fall of Potential Methods." In one case a known resistance is used with the voltage drop, and in the other the current is used with the volts drop to obtain the ohmic value of the unknown resistance.

Trouble with Hand Rope of Elevator—We have considerable trouble from the hand rope on a freight elevator becoming too tight or too slack for use within an hour or two after the length has been adjusted, and find the rope has turned the swivel at the turnbuckle. What is the cause and remedy? E. P.

This trouble is common with wire hand ropes for operating elevators, especially where long ropes are required for elevators passing through a number of stories. Tightening and slackening of the rope is due to expansion and contraction of the wire from changes of temperature and swelling and shrinkage of the hemp core due to variable moisture of the atmosphere. For most situations the use of tightener pulleys for automatically preserving the tension would be impracticable and it is necessary to depend on hand adjustment of a turnbuckle. The bother occasioned by a slackened hand rope coming off the sheaves may be avoided by providing guards each side of the sheaves.

Feasibility of Using Air Lift—We use two duplex pumps for raising water from three driven wells that are 110 ft. deep. The pumps are located in a pit that is about 10 ft. deep, but the water level in the wells is so low that the suction is 25 to 28 in. vacuum and there is considerable pump slippage. Would it not pay to install an air lift to raise the water to the pit and pump from the pit? G. H. D.

The conditions are favorable to use of an air lift and as it is quite evident that by pumping, the level of the well water drops beyond the suction lift of the pumps, the pumps must be lowered or some type of deep well pump should be installed. By submergence of air lifts within about 3 ft. of the bottoms of the wells, there would be fair air lift efficiency for delivery to the pump pit, and nearly as good efficiency if the air lifts discharge two or three feet above the surface of the ground.

Transformers Connected Delta and Star—Will three transformers connected delta have the same capacity if connected star? M. A. B.

When transformers are connected in delta as in Fig. 1, the current per terminal is 1.732 times the current per transformer and the voltage between terminals is that across each transformer, that is, if the current in each transformer winding is 100 amperes, the current per terminal will be 100 × 1.732 = 173.2, and if the volts across each winding is 1000, the pressure between terminals is also 1000. In the star connection, Fig. 2, the current per terminal is that per winding, but the voltage between terminals equals the volts per transformer times 1.732. In other words, if the current per winding is 100, the amperes per terminal will also be 100, against 173.2 for the delta connection. With 1000 volts across each transformer in the star connection, the volts between terminals will be 1000 × 1.732 =1732, compared with 1000 for the delta connection. The total volt-amperes in each case equals volts × amperes × 1.732, which gives for the delta connection 1000 × 173.2 ×1.732 = 300,000, and for the star connection 1732 × 100 × 1.732 = 300,000, giving the same capacity in each case. However, it is evident that for this to be possible the volts applied to the star-connected bank of transformers must be 1.732 times as great as for the delta connected. A bank of three transformers connected delta and operating on a 6600-volt circuit will have the same capacity as the same bank connected star and operating on 11,000 volts, that is, 11,000 = 6600 ×1.732, approximately.

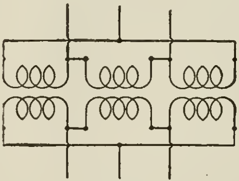


FIG. 1

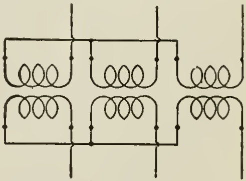


FIG. 2

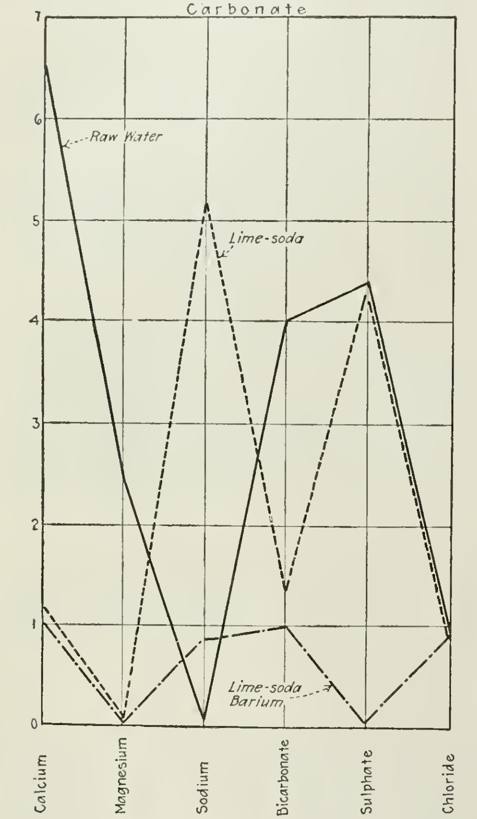
[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Softening Boiler-Feed Water*

By W. F. Monfort

It has been known since 1845 that the use of lime for softening certain waters gave excellent results. The later-developed use of soda ash with lime was a great advance. With some waters such treatment does all that can be desired, and it has followed that frequently only this treatment has been considered. The situation is like that when slow sand filters were installed in this country to purify very turbid waters, to which they were not adapted. The hope was strong, the principle unsound, the result disappointing.

The larger railway systems have found it advantageous to install water-treatment plants. Many industrial enterprises also use water softeners regularly and find economy in installations that take the strain from boilers, save coal at war prices and maintain expensive plants at high efficiency when labor and material are at a premium. But a larger number of small and medium-sized water and light plants are still using water without treatment. The adequate treatment of a boiler-feed water should be based on a complete analysis of the water; this should take place outside the boiler and should be tested by its results.



GRAPHIC REPRESENTATION OF WATER BEFORE AND AFTER TREATING

A proper analysis of a water can be expressed in terms of actual facts developed; it does not involve any hypothetical combinations, which are at best misleading, since no one knows and few will agree as to the probable combinations occurring in a water wherein most, if not all, of the chemical components are dissociated to a large extent. As an instance may be cited the varying statements of the analysis of a single water according to the scheme of combinations favored by several analysts and boiler-compound people. Most of them are based upon varying conceptions of what residue will be formed in a boiler as evaporation proceeds. Scale deposits in different parts of the ordinary boiler are not of fixed and invariable composition, and our knowledge is here incomplete. It is probable that the reactions differ in various parts of the same boiler at a given time, and that the full range of reactions is not given in the whole collection of combinations in Table I.

TABLE I. HYPOTHETICAL COMBINATIONS REPRESENTING ONE ANALYSIS

Parts per Million

	1	2	3	4	5	6	7
Silica	29	29	29	29	29	29	29
Iron oxide	..	.	.	0.7	..	0.7	0 7
Iron carbonate	1 6	1 6	1.6	.	1.6	.	.
Calcium bicarbonate	210	210	36	8	126	130	210
Calcium sulphate	..	.	147	147	68	68	.
Calcium chloride	..	..	.	19	.	..	.
Calcium nitrate	..		.		4		.
Magnesium bicarbonate	20	20	96	96	96	96	24
Magnesium sulphate	62	62	..		..	..	60
Sodium bicarbonate			94	128	.		.
Sodium sulphate	80	80		..	83	83	83
Sodium chloride	10	13	10	..	10	20	20
Sodium nitrate	4	.	4	..		..	..
Potassium chloride	12	9	12	..	12	..	
Potassium nitrate	..	5	..	..	..	..	..
Sum	429	430	430	428	430	427	427
Scale-forming constituents	233	233	255	257	236	235	236
Foaming constituents	106	107	80	82	105	103	103

That the analysis should be complete is indicated by the variety of troubles in boiler-feed waters due to silica, sulphates, calcium and magnesium, bicarbonates, sodium and potassium, nitrates, iron, manganese and chlorides. Silica in some waters causes an abundant hard scale. Its treatment calls for special methods.

Sulphates in conjunction with calcium yield, on evaporation, a hard scale of calcium sulphate in some parts of the boiler. The common treatment is the addition of soda ash. If made to the feed water, there is a high concentration of sodium compounds in the boiler along with precipitated calcium carbonate, which combination favors foaming, wet steam, waste of packing and gaskets, and other ills. Even with pretreatment foaming may follow.

Calcium and magnesium in waters of high bicarbonate content yield a soft scale, abundant and wasteful of heat. It is difficult to prevent pitting and corrosion of rivets, seams and plates when the deposited soft scale interferes with quick transmission of heat. If precipitated and collected before the feed water is introduced into the boiler, the economy is great. Corrosion is promoted by deposit of those magnesium salts which decompose with the liberation of acids (magnesium, chloride, sulphate, nitrate) and such excesses of carbonic acid as are frequent in many waters.

TABLE II. RESULTS OF SOFTENING OF THREE TYPES OF WATER

Dissolved Solids		Calcium	Magnesium	Sodium	Bicarbonate	Carbonate	Sulphate	Chloride
523	1—Raw	6.56	2 63	0 02	4.00	0	4 38	0.84
401	Soda-lime	1.2	0 1	5 22	0	1.3	4 38	8 84
99	Alternate	1 0	0	0 84	0	1	0	0.84
162	2—Raw	3 5	2 9	1.3	7.8	0	0.05	0.1
121	Lime-acid	0 6	0	1 3	0	0.6	1.2	0 1
1277	3—Raw	2 6	1.33	1.56	2.91	0	2.16	0.34
222	Soda-lime	0 9	0.1	2.50	0	1	2.16	0.34
158	Alternate	0.9	0.1	1.66	0	1	1.23	0.34

Cost of Treatment, Cents per 1000 *Ga.*

1—Soda-lime	3 42
Alternate	15.38
2—Lime-sulphuric acid	1.09
3—Soda-lime	0.89
Alternate	4 27

How the nature of a water and the results of treatment may be shown is illustrated in the accompanying graphic representation of a water before and after treatment. Before treatment it was high in calcium and sulphates, forming hard scale, but low in other constituents; with soda ash and lime the sodium content was increased and foaming resulted. Using another treatment, lime soda ash and a barium compound, it was possible to render this a desirable soft water containing little more than one pound dissolved matter per thousand gallons, causing neither hard scale nor foaming.

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*Excerpt from paper on "Present Tendencies in Water Purification," presented before the Missouri Association of Public Utilities.

Treatment must be adapted to the individual supply; and this is one of the reasons for neglect. At the present time the high cost of coal makes water treatment well-nigh imperative. With well supplies of practically constant composition, maintenance of a successful softening plant, once installed, offers no difficulty. With surface supplies some additional supervision is required, but first cost and operation would be more than offset by boiler economies.

Another type of water, common in parts of Illinois, is represented in the analyses in Table II, representing the water before and after treatment with lime and sulphuric acid. The figures given are on the same scale as those in the former instance cited. Silica in this case is not an appreciable factor and is suppressed with other unessentials as before. A third is an average sample from the Missouri River near its mouth; two kinds of treatment are applied, with the results indicated.

In the table the cost data offered are based on before-the-war prices; present costs are uncertain, because of the downward tendency that should appear soon. Even allowing for lime at twice the former price, with soda ash at the double price and other reagents at current prices, the cost would not be more than doubled. There is still room for economy with the present prices for coal.

Summarizing the knowledge of water purification for city supplies has grown to an art within less than a century and has led to a satisfactory improvement in the quality of drinking water furnished to cities large and small.

Purification of boiler-feed waters has developed, but practical application has been far less general. The economies growing out of this knowledge, applicable in water and light plants generally, may well find more extended use at this time, when revenues are seriously impaired.

Feed water should be treated and clarified before it enters the boilers. Treatment should be determined after a complete analysis, which should be so expressed as to give the actual facts without the admixture of guesses.

Hays School of Combustion

A correspondence course in combustion—something the United States Fuel Administration had in contemplation before its services were suddenly curtailed—is now ready for prospective students. The author is Joseph W. Hays, with whom many engineers are already acquainted or at least familiar with his writings. Besides writing all books belonging to the course, Mr. Hays will supervise examinations and educational matters. The school has a staff of reviewing and advisory editors, consisting of David Moffat Myers, formerly advisory engineer for the Fuel Administration; Joseph Harrington of Chicago, an authority on combustion; Fred R. Low, editor of *Power;* Arthur L. Rice, editor of *Power Plant Engineering;* and Prof. S. W. Parr, chemist, University of Illinois. This staff reviews and passes upon all manuscript prepared for the course. The commercial end of financing and operating the Hays School of Combustion has been undertaken by R. C. Acers, president; L. C. Petitt, vice-president and treasurer, and H. R. Newlean, secretary. General offices are located in the State-Lake Building, Chicago, Ill.

From the prospectus and from the knowledge that it will be prepared and supervised by a noted educational staff, the course should prove of interest and value to all men interested in the production or use of power. It is especially commended to chief engineers and firemen of stationary and locomotive boilers, plant owners and managers, shop engineers, mine operators, electrical engineers, erectors of boiler-room equipment, salesmen of power-plant apparatus and of coal, and in fact any man concerned in keeping fuel costs down and fuel efficiency up, whether he be employer, employee or advisor.

Fuel conservation is one of the vital problems of the day. Coal prices are high and the saving of fuel means more than it did years ago. The remedy for fuel waste is a thorough knowledge of combustion and the initiative to apply that knowledge in everyday boiler-room operation. What is needed is men trained to the requirements of economical operation by men who have had years of practical experience. There is a scarcity of good combustion engineers, and to the right men the possibilities are promising. Due to existing conditions a knowledge of combustion is vital and this applies to the operator and all concerned.

In the Hays School the idea is to give the training in the shortest and simplest form possible and in concise language that can be understood without previous technical training. The plan is to sell service—not a set of books—with the object of turning out good combustion engineers.

The course consists of twelve instruction books, each separately bound. With the first instruction book the student receives a permanent cover in buckram, into which is inserted each succeeding book as it is received. The student's progress is determined by examination questions accompanying each book, which are designed to test his knowledge as to details and general principles. When a satisfactory grade has been passed, he receives the next book and, after satisfactorily completing the course, is entitled to the Hays Diploma, which serves as an assurance that the holder is a capable combustion engineer. Still the school is not through with the student. Through its service department it will endeavor to place him gratis in a favorable position. If he is already employed in a power plant, the employer (unless the student otherwise specifies) will be notified as soon as his employee takes up the course. He will be kept informed of the student's progress, and at the same time the student will be sent definite suggestions on how to demonstrate to his employer the money-saving value of his increased knowledge, such procedure being designed to improve the position of the student and increase his salary. An outline of the course follows:

Book 1: Introductory chapter, history of steam, etc.

Book 2: Boiler furnaces and general rules of practice.

Book 3: General discussion of drafts—natural and artificial.

Book 4: Natural fuels and all about them, including methods of coal, oil and water analysis.

Book 5: Physics and the chemistry of combustion. Combustion analysis.

Book 6: Operation of boiler plants with manufacturers' illustrations of boilers and other apparatus. Applied combustion analysis.

Book 7: Smokeless combustion. Applied combustion analysis.

Book 8: Boiler and furnace testing. Applied combustion analysis.

Book 9: Dealing in detail with such important specific matters as cannot be properly covered in the preceding instruction books.

Book 10: Industrial gases and the gas producer.

Book 11: Gas and oil engines.

Book 12: The combustion engineer and his work. Keeping charts and cost figures.

Frank W. Townsend

Frank W. Townsend, for thirteen years chief engineer of the Narragansett Electric Lighting Co., Providence, R. I., died at Saranac Lake, N. Y., Aug. 17, after a lingering illness.

Mr. Townsend laid the foundation for his technical work by starting in the machine shop. He attended night school and studied hard the few engineering textbooks that came his way, later accepting a job in a shop doing marine work. From there to the engine room of an ocean-going steamer was but a step. He was connected for several years with the Clyde Steamship Co. and other Atlantic lines.

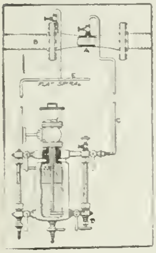
Returning to shore work, Mr. Townsend found for himself a responsible berth in the power-plant industry, eventually receiving the appointment as chief engineer in the 80,000-kw. turbine plant of the Narragansett company. He was 45 years old at the time of his death and had been in failing health for over a year.

Condensed-Clipping Index of Equipment

Clip, paste on 3 x 5-in. cards and file as desired

Lubricator, Meyeringh Proportional

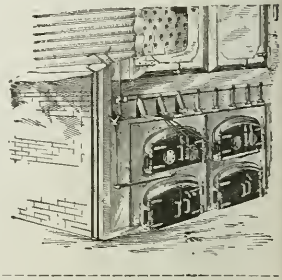
Oil Well Supply Co., Pittsburgh, Penn.
"Power," July 15, 1919



The proportional lubricator feeds oil to a steam line automatically and keeps the quantity of oil fed proportional to the steam flow through the line. It consists of an oil reservoir, condensing pipe and nozzle. The difference in gage pressure between the full area of the steam pipe and the contracted area of the nozzle is such that the quantity of oil flowing through the regulating valve will be proportional to the quantity of steam flowing through the steam line. The advantage of this device is that it can be installed in a steam line feeding one or more pumps or engines at the same time.

Scraping Device, C. E. C. Tube

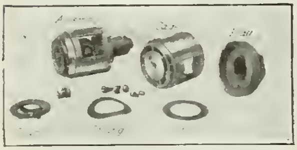
Combustion Engineering Corporation, 11 Broadway, New York City.
"Power," July 15, 1919



Openings are provided in the front and rear walls of a boiler setting, through which a light hook may be used for scraping the cinder from the bottom and sides of the lower row of tubes. The scraping wall boxes are made in sections with three, four and five doors, and are spaced the same distance apart as the boiler tubes. The openings, however, are placed halfway between the tubes so that the sides of the tubes may be reached, as well as the bottom, and also the bottom of the second row of tubes. The boxes are protected from radiant heat, and are fitted with cast-iron swinging doors or covers.

Valve, Sullivan "Wafer" Air-Compressor

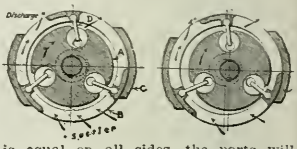
Sullivan Machinery Co., Chicago, Ill.
"Power," July 8, 1919



These valves are held to their seats by flat annular steel springs. They open against guard plates which give a wide port opening with a minimum of clearance volume. The valve spring and guards are accessible by removing a screw plug. The valves can be located close to the bore of the cylinder, thus keeping down clearance losses. When the valve is raised and the unloader is in action, no air is compressed.

Pump, Hy-Pres Oil

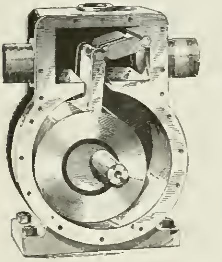
D. H. McCorkle Manufacturing Co., Oakland, Cal.
"Power," Sept. 9, 1919



This pump is of the variable capacity, constant speed and constant pressure type. It consists of synchronously rotating two engaged bodies of different diameter on different centers. In operation the center of the rotor and the center of the rotating carrier arrangement are concentric, and as the displacement is equal on all sides, the ports will rotate without displacing any liquid. By means of an external adjusting handwheel the center of the carrier ring can be moved in a horizontal direction along the center line, and in this position the displacement diametrically across the pump on a center line is unequal and the volume of liquid forced through the pump depends on the degree of eccentricity between the two revolving parts.

Pump, Thompson Return-Line Vacuum

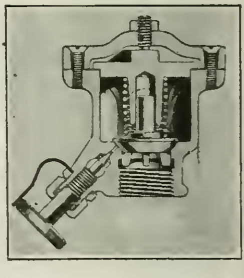
Thompson Manufacturing Co., Des Moines, Iowa.
"Power," July 15, 1919



This pump has but three moving members—the crank, the impeller, and the hinged plate. The last separates the suction and the discharge side of the pump cylinder. The impeller and pump casings are cylindrical, and the impeller is at no time in contact with the casing. Shaft is fitted with ball bearings. As the crank turns in a clockwise direction, it gives the impeller an eccentric motion; as the water enters the inlet pipe, it discharges into the space between the rotor and the casing, and as the rotor revolves, this water is carried around until it escapes through the discharge pipe.

Valve "Adjusto" Generator

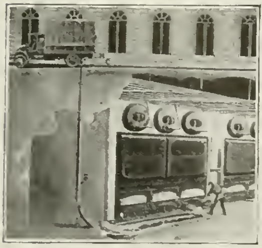
The W. M. Powell Co.
"Power," Sept. 9, 1919



The "Adjusto" generator valve for use with gasoline engines is of the throttling type with a needle-valve adjustment attached. This throttling feature enables the operator to regulate the engine speed and eliminate the ordinary butterfly valve. The gasoline supply is controlled by the needle valve, which is held to its adjustment by a curved spring and engages the knurled edge of the regulating wheel. Numbers on the wheel show the various degrees of openings. The gasoline connections are $\frac{1}{8}$ or $\frac{1}{4}$ in. female iron pipe. The generator valve is especially adapted for marine engines, either two- or four-cycle types.

Ash Conveying, Pneumatic

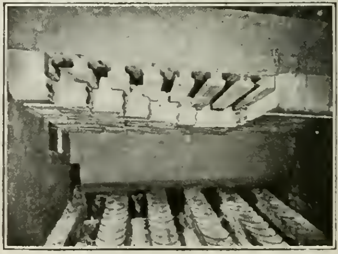
Ash Removal, Inc., 347 Madison Ave., New York City.
"Power," July 15, 1919



A 3 x 3 ft. concrete pit is built in front of the boilers and covered with sectional sheet iron, making it possible to uncover any section of the pit. An 8-in. conveying line extends from beneath the concrete pit to a point under the sidewalk at the curb. Intakes are inserted in the conveyor line at convenient points. A 6-ton capacity conveyor truck, equipped with a high-pressure blower and driven by the truck motor connects with the outlet of the conveyor pipe and the ashes are drawn into it and then discharged into a dump truck for carting away. The conveyor pipe is sold to the plant owner, but a charge is made for disposal of ashes.

Arch, Liptak Double Suspension

Liptak Fire-Brick Arch Co., 844 Builders' Exchange, Minneapolis, Minn.
"Power," July 22, 1919



The distinguishing characteristic of this arch is that it is of a suspension design, consisting of a reserve arch over and supporting the lower arch that is exposed to the fire. The lower arch can be burned away without necessitating a shutdown, as the reserve arch protects the cast-iron supporting beam. Each beam is equipped with a replacement tip so that if the end blocks spread away exposing and damaging the supporting members, it will be necessary to replace the tip only.

Patented Aug. 20, 1918

Automotive Fuel Situation Discussed

Prominent executives and technical representatives of the automotive and fuel industries met at the University Club, New York, on the evening of Aug. 21 to discuss problems relating to the nature and future supply of fuel suitable for automotive purposes, and ways and means for utilizing this supply most efficiently and satisfactorily in the automobiles and other automotive vehicles now in the hands of users, as well as in those of vehicles to be constructed in very large quantities in the future.

In the absence of Charles F. Kettering, past-president of the Society of Automotive Engineers, and its official representative on the Automotive Conference Committee, C. F. Clarkson, general manager of the Society of Automotive Engineers, read a statement in which Mr. Kettering said in part:

"The fuel problem as it exists today divides into two general classes, one of which belongs to the automotive manufacturers and the other to the fuel manufacturers. However, a complete solution in either case is impossible without the hearty coöperation of both industries." Mr. Kettering then outlined in a general way some of the research work bearing upon the fuel problem which has been conducted in his own laboratories. In general the statement was to the effect that much basic research is still necessary to determine just what phenomena occur during the combustion of fuel in the engine cylinder, but that the research to date appears to indicate that a further study of the problems will enable a satisfactory engine fuel to be produced even though it becomes necessary, as seems most likely, to cut still deeper into the crude than is now common practice.

The subject of fuel specifications was discussed at some length and it was decided that a fixed specification would be detrimental to both producer and consumer, but that a flexible specification which would be changed from time to time as the exigencies of the fuel supply and demand may dictate would be useful to all concerned and a great assistance to the automotive manufacturer in enabling him to design his product in such way as to utilize the fuel most satisfactorily.

It was generally agreed that the numerous problems involved in a satisfactory settlement of the situation, rendered thoroughgoing and extensive research work very necessary, and that the representatives of the automotive industry would outline in considerable detail the various difficulties which the automotive engineer and car user faces in the use of present-day gasoline. An endeavor would be made to state clearly the fuel problem as it appears to the automotive industry for the purpose of aiding the fuel industry to prepare to meet the problem, so far as this can be done by the refiners. In addition, the representatives of the automotive industry indicated a desire to adapt the apparatus produced by them to the fuel which the petroleum industry, faced on the one hand by the increasing demand, and on the other by a diminishing supply of crude, can produce.

Aims of the Geographic Sections of the N. E. L. A.

In response to a request for his ideas regarding the scope and objects of the Geographic Sections, which are being enlarged, as discussed at the 42nd annual convention held at Atlantic City, N. J., May 20-24, 1919, President R. H. Ballard of the National Electric Light Association transmitted to President Thomas Sproule of the Pennsylvania Electrical Association, which convened at Bedford Springs, Penn., Sept. 4, the following in communication form:

In the Geographic Section we provide the electrical industry with the intermediating link between the central station, which is the unit of activity in which ideas naturally germinate, and the National Electric Light Association, which is transcontinental in its policies and its aims.

The greatest opportunity is offered for personal contact and interchange of ideas between executives and employees of the companies and all others interested in the electrical industry within the territory where conditions are frequently identical and unusually similar.

The results of progress made and new ideas demonstrated by one company, may be quickly conveyed to other companies in the same territory.

Opportunity is afforded men to think in broader terms and to apply their reasoning along sectional lines. This is the logical sequence of development—company to section; section to nation. The natural foundation for this line of progress is the company section, and its importance is inestimable.

The maximum opportunity is presented for cementing all branches of the industry into one harmonious whole; of increasing the sphere of influence exercised by those engaged in our profession, and in eventually creating a better understanding between the public served and those whose duty it is to serve the public.

In the Geographic Section a complete understanding should be reached between central stations, manufacturers, jobbers and contractor-dealers, as to the rightful place in the industry occupied by each group and in establishing the relations of one branch of the industry to the others.

In the Geographic Section we have a place where misunderstandings, friction, petty jealousies and fancied injuries can be ironed out and adjusted by bringing about a full and complete realization by all members of the section of the responsibility of service to the public and the joy of working out practical accomplishments of the ideal.

In the Geographic Section can best be worked out a definite plan by which the public may be kept informed on the true status of utility service in the district served.

In the Geographic Section there is ample opportunity for constructive initiative, and the opportunities for its exercise could be amplified indefinitely, the scope of achievement having no limitation but brains and ability.

We have the medium of crystallization; demonstrated and applying locally when local, and making universal when universal, all of the constructive creative forces that exist in the minds of the great membership of the National Electric Light Association.

Thirteenth Annual Convention of the A. I. S. E. E.

With the Hotel Statler in St. Louis as headquarters, the Association of Iron and Steel Electrical Engineers will hold its 13th annual convention Sept. 22-26. A tentative program has been prepared and contains the following:

Standardization Committee report, by T. E. Tynes, chairman; Educational Committee report, by A. B. Holcomb chairman; Safety Committee report, by Walter Greenwood, chairman; Electric Furnace Committee report, by Ralph D. Nye, chairman.

"Organization of the Electrical Department in the Steel Industry," joint paper; "Organization of the Operating Force," by H. C. Cronk; "Electrical Repair Shop," by C. A. Menk; "Storeroom and Spares," by T. E. Tynes; "Educational Training for Electrical Employees," by B. A. Cornwell; "Operation and Inspection," by A. Morgan and J. J. Booth; "Records and Testing," by R. B. Gerhardt; "Alternating Current Versus Direct Current for Table Motor Drive," by W. S. Hall; "High-Speed Motors with Herringbone Gears Versus Slow-Speed Motors," by J. E. Fries; "High-Temperature Furnaces," by C. A. Winder; "Meter Equipments in Steel Mills," by Paul M. Lincoln.

General discussion on the following topics: "Overload Protection on Cranes," by A. G. Place; "Crane Controllers," by James Maloney; "Motor Starters," by Walter C. Kennedy; "Design, Operation and Upkeep of Lifting Magnets," by James Farrington; "Recent Improvements in Industrial Control," by H. D. James; "Present Status of Arc Welding in the Steel Industry," joint paper by A. Churchwarden, of the Wilson Welder and Metals Co., H. L. Unland of the General Electric Co., A. M. Bennett of the C. & C. Electric Arc Welding Co., R. E. Kinkead of the Lincoln Electric Co., a representative of the Electric Arc Cutting and Welding Co., C. B. Waters of the Arcweld Corporation and A. M. Candy of the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn.

What is said to be the largest airplane engine in the world was recently put under its first test in England. It is reported to be of 1000 nominal horsepower and to develop about 900 hp. at normal working speeds.

Inspection and Life Tests of Incandescent Lamps

The total number of lamps offered for delivery to the Government purchasing authorities during the past fiscal year was over 5,000,000, of which about 600,000 were rejected on the initial inspection at the factory, which covers the mechanical qualities of the lamps and their rating in regard to power consumption and efficiency. In this initial inspection samples are selected for the burning or so-called lift tests. During the year nearly 3500 lamps were subjected to this life test, and with few exceptions the tungsten lamps, both vacuum and gas-filled, supplied under Government contracts, had a life considerably in excess of the 1000 hours of burning required by the standard specifications.

At the request of the General Supply Committee, tests were made in connection with bids of various manufacturers for the contract for the next fiscal year, and a considerable range in quality among the lamps submitted was indicated. It is probable that the information obtained by these tests alone repays the total cost of lamp work for the year.—*Commerce Reports.*

Public-utility generating plants of this country during March produced 1,300,924,000 kw.-hr. generated by water power and 1,842,214,000 kw.-hr. generated by the use of fuel, making a combined total 3,143,138,000 kw.-hr. Figures have been compiled by Division of Power Resources, United States Geological Survey, and embrace approximately 89 per cent. of the plants throughout the country. New York leads in amount of electric energy produced, showing the largest amount of current generated both by water power and by fuel plants. New York state manufactured 222,318,000 kw.-hr. by water power and 228,191,000 kw.-hr. by fuel plants. California is next in the generation of power by water, with a total of 215,914,000 kw.-hr., but Pennsylvania has the second largest output, showing the largest output generated by fuel next to New York. Pennsylvania produced 62,509,000 kw.-hr. by water power and 246,989,000 kw.-hr. by fuel.

Domestic Exports of Air-Compressing Machinery

The following statement issued by the Bureau of Foreign and Domestic Commerce shows the domestic exports of air compressing machinery during June of this year:

Countries:	Dollars	Countries:	Dollar
Belgium	15,257	Argentina	10,891
France	128,971	Brazil	20,141
Italy	79,415	Chile	2,497
Netherlands	5,892	Peru	857
Norway	4,709	Uruguay	700
Russia in Europe	6,750	Venezuela	2,250
Spain	74,644	China	323
Sweden	1,446	British India	5,018
England	43,401	Dutch East Indies	3,175
Scotland	1,441	French East Indies	7,341
Canada	40,405	Japan	68,992
Costa Rica	18	Australia	5,593
Panama	1,166	New Zealand	450
Mexico	12,373	Philippine Islands	6,731
Miquelon, Laogley, etc	1,000	British South Africa	3,270
Newfoundland and Labrador	112	Portuguese Africa	132
Cuba	20,419		
Dominion Republic	90	Total	575,870

The Board of Standards and Appeals of New York City held a public hearing Sept. 3 on a tentative draft of amendments of rules governing the storage and use of fuel oil and the construction and installation of oil-burning equipment. The hearing was attended by representatives of the American Society of Liquid Fuel Engineers, leading oil companies and many manufacturers of oil-burning equipment. The information presented was taken under consideration by the board and there will be another public hearing on Wednesday, Sept. 17, at 10 a.m., in room 919, Municipal Building. It is expected that copies of the amended draft of rules for consideration on the 17th inst. will be available for distribution on and after Sept. 11.

The results of the present lack of transportation in China are shown by the fact that, while the cost of mining coal at Siwan, in Kwangsi, is reported to be about $1 a ton, the expense of moving it to Canton is about $11 a ton. Since the coal is not of high grade, it cannot compete with coal imported from other places by sea, and so the mines have been closed and the expensive machinery is idle. The tin mines at this place are a continuation of the deposits in Hunan, but are not even mapped.—*Commerce Reports.*

Personals

W. C. Tyler, New York district manager for the Poole Engineering Co., Baltimore, has been appointed general sales manager.

Charles W. McKay, author and technical writer of industrial subjects, has taken charge of the appraisal division of L. V. Estes, Inc., Chicago, Ill.

Tell Berna, formerly district manager for the Cutler-Hammer Manufacturing Co., Cincinnati, Ohio, has become associated with the G. A. Gray Co., of same city, as sales engineer.

Edward R. Cardinal, formerly district sales manager for the Carpenter Steel Co., and until recently president of the Cardinal Tool Co., of Philadelphia, has been appointed district sales manager of the Tacony Steel Co., Tacony, Philadelphia.

Charles E. Gradwell, of Gradwell & Phelis, Birmingham, England, agents for the Hofmann-Sproul Co., of Philadelphia, has sailed for home. After placing certain contracts in England Mr. Gradwell will leave for China, where he has been appointed special buyer of scrap for the Hofmann-Sproul Co.

E. L. Sullivan, who has been connected with the McDonough Regulator Co. for the last ten years, has been appointed to represent the Green Engineering Co., of East Chicago, Ind., at 2545 Oliver Building, Pittsburgh, his district to include western Pennsylvania, eastern Ohio and western West Virginia.

Herbert C. Hoover is expected to arrive in American about the middle of September. The engineers of America, under the auspices of the American Institute of Mining and Metallurgical Engineers, have decided to express their admiration for Mr. Hoover's services in international affairs during the war by giving him a banquet, to be held in New York, shortly after his arrival.

Harry M. Giles has been appointed general superintendent of the South Philadelphia Works of the Westinghouse Electric and Manufacturing Co. Mr. Giles, who succeeds the late Oscar Otto, killed in an automobile accident last month, has risen from the ranks in the Westinghouse organization. For a number of years he has been superintendent of marine erection, a position to which he was appointed by H. T. Herr, when the electric company absorbed the machine company.

Engineering Affairs

The National Electric Light Association, New England Section, will hold its annual convention at the Hotel Griswold, New London, Conn., Sept. 16-18.

The National Safety Council will hold its eighth annual safety congress at the Hotel Statler, Cleveland, Ohio, Oct. 1-4. Exhibits will be at Gray's Armory.

Miscellaneous News

The Division of Operations of the United States Shipping Board announces that the Board has awarded to the Mexican Petroleum Corporation the contract for 500,000 bbl. of grade "C" oil fuel to be taken in cargo lots during the next twelve months. The price is $1.18 per barrel. The point of delivery is the United States Shipping Board bunkering station at St. Thomas, W. I.

San Joaquin Light and Power Co., Fresno, Calif., has let contracts amounting to over $1,000,000 for machinery and equipment to be installed in the new Kerckhoff power plant. Three 15,000-hp. turbines with generators will be installed.

The Electrical Exposition, which has been held in New York annually since 1907, excepting last year, will be held this year at Grand Central Palace, beginning Sept. 24 and lasting ten days. This year's show will be especially varied and interesting because it will disclose high-tension developments in the electrical field for the last couple of years.

The War Department is offering for sale the town of Nitro, W. Va., a complete industrial comunity embracing 737 manufacturing buildings, housing accommodations for 20,000 people, and the utilities and civic improvements that constitute the conveniences of a modern city. Nitro, built by the Government at a cost of approximately $70,000,000, is the site of the second largest smokeless-powder plant in the world. The bids will be opened at noon, Sept. 30, 1919, at the office of the chairman of the Ordnance District Salvage Board, 1710 Market St., Philadelphia, Penn.

The Stoker Manufacturers' Association will hold its fal meeting at French Lick, Ind., on Nov. 3-5. This organization has had several important committees in session during the year, and interesting reports of the stoker situation throughout the country will be presented at that meting. S. L. Nicholson, assistant to the vice president of the Westinghouse Electric and Manufacturing Co., is expected to have some very interesting remarks to make on the future of business in the country.

Business Items

The C. A. Willmarth Co. has moved its office to Chelsea, Mich., where its plant, with latest improved machinery and process for making peat fuel, is nearly completed.

The Busch-Sulzer Bros. Diesel Engine Co., St. Louis, Mo., has opened an Eastern sales office at 60 Broadway, New York City, in charge of George D. Pogue, with Stanley Wright as assistant.

The American Steam Conveyor Corp., Chicago, announces the appointment of Morton McI. Dukehart & Co., as its representative in Baltimore and the surrounding territory, which includes all of Maryland, the District of Columbia and a few counties in Pennsylvania, Delaware, West Virginia and Virginia.

The Sullivan Machinery Co. announces the appointment of R. S. Weiner as district manager at El Paso, Texas, succeeding Don M. Sutor. Mr. Sutor has been transferred to the company's St. Louis office as district manager for Missouri, Eastern Texas, Oklahoma, Kansas, Western Kentucky and Western Tennessee.

Frank D. Chase, Inc., Industrial Engineers, Chicago, are preparing plans for a new heating plant to be erected for the Samson Tractor plant at Janesville, Wis. The first unit will have a capacity of 2000 hp. It will be equipped with Stirling boilers and Taylor stokers. Coal will be stored in an inclosed building. It is delivered to the bunkers above the stokers through a track hopper, crusher and elevating system. The ashes also will be removed by mechanical means, and a crane will be installed to handle both the coal and ashes in an emergency, as well as for handling of storage coal to the track hopper. This first unit will serve buildings now erected or under construction for the Samson plant, and will be doubled as the plant increases.

\Trade Catalogs

The Earle Gear and Machine Co., Philadelphia, Penn., has issued a new catalog fully illustrating and describing Earle centrifugal pumps. Copy free upon request.

The Under-Feed Stoker Co. of America has recently issued a 32-page catalog, nicely printed, which completely illustrates and describes the Jones "Standard" stoker.

The United Stokers Corp., Chicago, Ill., has issued a 7-page bulletin, No. 101, descriptive of Simplex conveyors for soot, dust and combustion ash. Copy free upon request.

The A. Y. McDonald Manufacturing Co., Dubuque, Iowa, has just issued its 53-page catalog No. 5 on "Oil Specials." Loading and unloading apparatus, swing joints, hand and power pumps, tank valves, and all such equipment for handling gasoline, kerosene and other liquid petroleum products are shown and described.

The Breeze Manufacturing Co., Newark, N. J., has issued a 34-page catalog on "Flexible Metal Hose-Tubing and Accessories." It illustrates and covers metal hose in detail for every type and method of winding, how it is applied and why, and what industries use it. It is the only booklet of its kind published in this trade. A copy may be had free upon request.

The Bonnot Co., Canton, Ohio, has just issued a 135-page catalog on "Holbeck Pulverized Coal Systems." It is an up-to-date book on the subject and contains much useful information for executives and engineers. It is copiously illustrated; several perspective views of complete coal storage and pulverized coal plants are shown, as well as various installations, processes, etc.

The Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has published an interesting, descriptive little bulletin (No. 138) entitled "Prospectus of Apprenticeship System," which intends to convey to the boy who is ambitious, desirous of obtaining a degree or learning a trade, the method by which his ambitions may be realized. The Allis-Chalmers Manufacturing Co., which builds everything in stationary power units, offers exceptional opportunities for learning trades, and its co-operative course is open to the boy who shows talent along mechanical lines as well as to the young man who has completed high school and then wishes to obtain a degree. A copy of the bulletin may be had free upon request.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F. o. b. mines, net tons	$2.60@3.10	$3.00@3.60
F. o. b. Philadelphia, gross tons	4.79@5.35	5.20@5.80
F. o. b. New York, gross tons	5.10@5.70	5.50@6.20
Alongside Boston (water coal), gross tons	6.85@7.35	7.10@7.85

Georges Creek is quoted at $3.70 per net ton, f. o. b. mines.

Pocahontas and New River are being quoted at $6.25@6.60 per gross ton f.o.b. Norfolk and Newport News, Va., in response to export demand. There are practically no sales for coastwise shipment.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5.95	$7.80	Pea	$5.30	$7.05
Egg	6.35	8.20	Buckwheat	3.40	5.15
Stove	6.60	8.45	Rice	2.75	4.50
Chestnut	6.70	8.55	Barley	2.25	4.00

Bituminous

Current quotations on spot coal, net tons, at the mines average about as follows:

	Spot
South Fork (best)	$3.25@3.50
Cambria (best)	3.00@3.25
Cambria (ordinary)	2.70@2.90
Clearfield (best)	3.00@3.25
Clearfield (ordinary)	2.70@2.90
Reynoldsville	2.70@2.90
Quemahoning	3.25@3.50
Somerset (best)	3.00@3.25
Somerset (poor)	2.65@2.75
Western Maryland	2.50@2.75
Fairmont	2.35@2.50
Latrobe	2.60@2.65
Greensburg	2.50@2.60
Westmoreland ¾ in.	3.50@3.75
Westmoreland run-of-mine	3.20@3.35

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

			Anthracite		
	Line	Tide		Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	6.35	8.20	Rice	2.75	3.65
Stove	6.60	8.45	Boiler	2.50	3.50
Nut	6.70	8.55	Barley	2.25	3.15
Pea	5.30	6.90			

Illinois

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3.25
Mine-run	2.35@ 2.50	3.00
Screenings	1.40@ 1.60	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2 25	$2.60	$2.40
Black Creek and Cababa	3.25	3.45	3.05
Jagger - Pratt Corona	2.85	3.00	2.45
Blacksmith	....	5.25	.....

Domestic quotations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cababa	5.00@$5.50
Corona	3.50
Jagger	3.50
Montvallo	5.50@$6.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

	Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$2.85*@3.05	$2.55	$2.25@2.50
Mine run	2.10*@2.35	2.35	1.60@1.70
Screenings	1.50*@2.20	2.05	.90@1.00

* Indicates prices on independent coal.

Williamson-Franklin rate to St. Louis is $1.07½; other rates $0.92½.

New Construction

PROPOSED WORK

N. H., Portsmouth—The Bureau of Yards and Docks, Navy Department, Washington, D. C., will receive bids until September 17, for the installation of a 100 kw. turbo generator, here. Estimated cost, $17,000. Noted August 26.

Conn., New Britain—Landers, Frary & Clark, Commercial St., are having plans prepared for the construction of a 6 story, 80 x 160 ft. and 50 x 160 ft. factory, on Center St. A steam heating system will be installed in same. Total estimated cost, $150,000. Max J. Unkelbach, 162 Main St., Arch.

Conn., Winnipauk—Monks & Johnson, Engr., 78 Devonshire St., Boston, Mass., will receive bids about September 15 for the construction of a 6 story, 80 x 130 ft. factory off the State Road, for the Norwalk Tire & Rubber Co. A steam heating system will be installed in same. Total estimated cost, $100,000.

N. Y., Bronx—The Board of Education received bids for installing heating and ventilating apparatus in P. S. 57 Crotona and Belmont Ave., from E. Ruetzler Co., 404 East 49th St., New York City, $115,712; Gillis & Geoghagan, 537 West Broadway, $118,776; D. J. Rice, 405 Lexington Ave., $122,267; for installing temperature regulating apparatus in P. S. 57, from the National Regulator Co., 145 East 34th St., New York City, $5800; Johnson Service Co., 123 East 27th St., New York City, $6349; Powers Regulator Co., Park Ave. and 40th St., $7588.

N. Y., Brooklyn—Rockwood & Co., 88 Washington Ave., will build a 7 story, 50 x 100 ft. garage on Waverly and Park Ave. A steam heating system will be installed in same. Total estimated cost, $100,000. G. A. Palcanis, Fanwood, N. J., Arch. Work will be done by day labor.

N. Y., New York—Buchman & Kahn, Arch. and Engr., 56 West 46th St., are preparing plans for a 16 story office building on 36th St. and 7th Ave. A steam heating system will be installed in same. Total estimated cost, $1,200,000. Owner's name withheld.

N. Y., New York—R. D. Kohn, Engr. and Arch., 56 West 45th St., will soon award the contract for altering 3 story, 50 x 75 ft. dormintory, and building two 3 story, 27 x 56 ft. and 41 x 152 ft. additions, on Havemeyer Ave., for the United Odd Fellows' Home. Steam heating systems will be installed in same. Total estimated cost, $125,000.

N. J., Freehold—The Board of Freeholders of Monmouth Co. is having plans prepared for a new heating and lighting plant, to include two 80 hp. boilers, and other equipment. Estimated cost, $25,000. C. A. Slocum, Long Branch, Arch.

Pa., Bethlehem—The Board of Education will receive bids September 16, for the construction of a 3 story, 180 x 250 ft. school, to be known as the South Side School. A fan system of heating will be installed in same. Total estimated cost, $300,000. V. T. Ritter, North American Bldg., Arch.

Pa., Philadelphia — Herman Miller, Arch., 1420 Chestnut St., is receiving bids for the construction of a 1 story, 36 x 80 ft. bank, at 23 East King St., for the People's National Bank, 7th and Girard St. A steam heating system will be installed in same. Total estimated cost, $100,000.

Md., Baltimore—The Maryland Casualty Co., Baltimore and Fayette St., and Guilford Ave., plans to build business buildings and community settlement, on 40th and 37th Sts., Cedar and Elm Aves. Plans include separate building for mechanical and power plant. Initial cost $1,500,000. Total estimated cost, $3,000,000. J. T. Stone, Pres.

Md., Baltimore—The Rice Motors Co., Madison and North Ave., has had plans prepared for the construction of a 2 story, 140 x 250 ft. garage, on Whitelock and McCulloh St. A steam heating system, plumbing and electric lighting will be installed in same. Total estimated cost, $100,000. Smith & May, 1133 Calvert Bldg., Arch.

Md., Baltimore—The Thermopak Co., Omaha, Neb., plans to erect a plant here, for the manufacture of iceless and saltless ice cream refrigerators. Total estimated cost, $150,000.

Md., Jessups—The State Board of Prison Control, 701 Union Trust Bldg., Baltimore, plans to alter and build an addition to the Maryland House of Correction, here. Steam heating plant will also be extended. Total estimated cost, $150,000. R. D. Case, Secy. T. W. Pietsch, 1210 American Bldg., Baltimore, Arch.

S. C., Charleston—The Bureau of Yards and Docks, Navy Department, Washington, D. C., will receive bids until September 17, for the installation of a 2500 k.v.a. turbo alternator, here. Estimated cost, $50,000. Noted August 12.

Ohio, Cleveland—The Citizens Savings & Trust Co., East 9th St. Euclid Ave., is having plans prepared for an 11 story, 140 x 200 ft. bank. A steam heating system will be installed in same. Total estimated cost, $8,000,000. Graham, Anderson, Probst & White, Railway Exchange Bldg., Chicago, Ill., Engr.

Ohio, Cleveland—Osborn Engineering Co., Engr., 2848 Prospect Ave., is receiving bids for the construction of a 3 story, 100 x 200 ft. factory addition on Warner Road, for the Ideal Tire Co., East 17 and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $125,000.

Ohio, Cleveland—The Pompeian Manufacturing Co., 2104 Superior Ave., is receiving bids for the construction of a 6 story, 75 x 150 ft. factory and office building, on East 24th and Payne Ave. A steam heating system will be installed in same. Total estimated cost, $250,000.

Ohio, Cleveland—The F. B. Stearns Motor Car Co., Euclid Ave. and Lakeview, plans to build a 4 story, 200 x 400 ft. factory addition on Lakeview Rd. A steam heating system will be installed in same. Total estimated cost, $300,000.

Mich., Algonac—The village will soon award the contract for installing 3 horizontal, motor driven centrifugal pumping units, two for domestic use and one for fire service; domestic pumps to deliver 350 gallons per minute against total head of 100 ft.; fire service pump to deliver 1200 gallons per minute against total head of 200 ft. K. A. Haulter, Village Pres. Engineering Service Co., P. O. Box 364, Port Huron, Engr.

Ill., Chicago—The F. M. Barton Co., Arch., 1510 Kimball Bldg., is receiving bids for the construction of a 4 story, 60 x 100 ft. warehouse, on Kostner Ave. and Taylor St., for the Adams-Elting Co., 716 West Washington Bl. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ill., Chicago—The city is having plans prepared for the construction of a 1 story, 80 x 95 ft. engine room and transformer station, on Chicago Ave. near Michigan Ave. Total estimated cost, $300,000. C. W. Kallal, 1017 City Hall, Arch.

Minn., Duluth—The city is in the market for one gas operated air compressor. P. G. Phillips, commissioner.

Kan., Augusta—The city is having plans prepared for the construction of a 3 story, 44 x 120 ft. hospital. A steam heating system will be installed in same. Total estimated cost, $100,000. J. R. Switzer, Augusta, Arch.

Kan., Hutchinson—The State Exchange Bank, c/o F. W. Cooter, pres., is having plans prepared for the construction of a 6 story, 75 x 150 ft. bank. A steam heating system will be installed in same. Total estimated cost, $300,000. W. E. Hulse & Co., Hutchinson, Arch.

N. D., Fort Yates—Cato Sells, Commissioner of Indian Affairs, Washington, D. C., will receive bids September 18 for furnishing materials and labor for the installation of a sewerage system, service lines and an electric lighting plant, at the Standing Rock School here.

Mo., Kansas City—J. Ray Samuel, purchasing agt., City Hall, will receive bids until September 17, for designing, constructing, delivering and erecting in the Quindaro Pumping Station 1 steam driven pumping unit, of the capacity to pump continuously at the rate of 50,000,000 gallons of water per 24 hours. Bids will be received on 2 types of pumping units, i. e., the centrifugal type of pump driven by steam turbine through reduction gears and the centrifugal type of pump driven by a vertical cross compound Corliss engine. W. G. Goodwin, Ch. Engr.

Mo., St. Louis—The Bush-Sulzer Brothers Diesel Engine Co., 2nd and Utah St., is building new manufacturing plant and will be in the market for power equipment and other machinery. Estimated cost, $30,000.

Mo., St. Louis—Hugh & Co., 10th and Walnut St., is in the market for motors, generators, boilers, oil and steam engines. C. G. Hugh, Pres.

Mo., St. Louis—C. Smith, 4000 South Broadway, is in the market for boilers, tanks, engines and turret lathes.

Okla., Tishomingo—The town will receive bids until September 18 for the construction of a complete electric lighting plant and distributing system consisting of power house, two 75 k.v.a. generators direct-connected to semi-Diesel oil engine, etc. Johnson & Benham, Firestone Bldg., Kansas City, Mo., Consult. Engr. Noted Jan. 21.

N. M., Albuquerque—The Rio Grande Light & Power Co., Sturges Hotel Bldg., has had plans prepared for the construction of a hydro-electric power plant, 140 mile transmission line, an auxiliary steam plant and large dam in the White Rock canyon, 40 miles north of here, on the Rio Grande River. Total estimated cost, $4,300,000. A. G. Hillberg, Sturges Hotel Bldg., Engr.

N. M., Hanover—The Republic Mining & Milling Co. plans to construct a steam turbo generator power plant in connection with its zinc mine here. Is in the market for hoists, electrical equipment, etc. Total estimated cost, $100,000. O. Wiser, Supt.

Can., Toronto—The King Edward Hotel is having plans prepared for the construction of a 15 story addition to hotel. A steam heating system will be installed in same, Total estimated cost, $1,500,000. O. E. Goldschmidt, 116 West 39th St., New York City, Engr. Esenwein & Johnson, Ellicott Sq., Buffalo, N. Y., Arch.

Ont., Toronto—John M. Lyle, Arch., Avondale Rd., will soon receive bids for the construction of a 3 story, 80 x 150 ft. tannery, on Cameron Ave., for H. B. Johnstone & Son, 774 Dundas St., E. A steam heating system will be installed in same. Total estimated cost, $130,000.

CONTRACTS AWARDED

Vt., Bennington—The Bennington Hospital has awarded the contract for the construction of a 2 story nurses' home, to C. M. Cruikshank, 103 Park Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $100,000.

Conn., Rockfall—The Russell Manufacturing Co., South Farms, has awarded the contract for the construction of a 2 story, 20 x 20 ft. turbine building, 2 story, 15 x 22 ft. engine room and pump house and 1 story, 36 x 25 ft. boiler house, to Denis O'Brien & Sons, Inc., 118 Asylum St., Hartford. Total estimated cost, $15,000.

N. Y., New York—The R. S. Howard Piano Co., 485 East 133 St., has awarded the contract for the construction of a 3 story piano factory on East 133rd St., to the Ettinger Construction Co., 44 Court St., Brooklyn. A steam heating system will be installed in same. Total estimated cost, $100,000.

N. Y., New York—B. F. Keith, 1564 Broadway, has awarded the contract for the construction of a 3 story, 200 x 228 ft. theatre, on Fordham Rd. and Valentine Ave., to the Fleischmann Construction Co., 531 7th Ave. A steam heating system will be installed in same. Total estimated cost, $300,000.

N. J., New Brunswick—The Hyjel Co., 40 Paterson St., has awarded the contract for the construction of a 2 story, 150 x 150 ft. theatre, to Fleischman Construction Co., 531 7th Ave., New York City. A steam-heating system will be installed in same. Total estimated cost, $250,000.

N. J., Trenton—The City Commission has awarded the contract for constructing 25,000,000 and 20,000,000 gal. electrical driven centrifugal pump, generator, motor, etc., in connection with pumping station, to Harry E. Stahl, 275 Bellevue Ave., $108,941. Noted July 22.

Pa., Erie—The School District has awarded the contract for heating and ventilating systems in proposed school building on Atkins and Brandes St., to Gannon & Carey Co., Erie, $48,000.

Mich., Manistique—Rome G. Brown, Metropolitan Life Bldg., Minneapolis, Minn., has awarded the contract for the construction of several paper mill buildings, to Siems, Helmers & Schaffner, foot of Market St., St. Paul, Minn. A steam heating system will be installed in same. Total estimated cost, $250,000.

Ill., Moline—The Board of Education has awarded the contract for a steam heating system for proposed 1 story school, on 16th Ave. and 25th St., to the Moline Heating & Construction Co., 320 16th St. Estimated cost, $10,972.

Mont., Lewistown—Fergus County has awarded the contract for the installation of a steam heating system in the County High School, here, to E. J. Kane, Lewistown. Estimated cost, $27,598.

Mont., Scobey—The city awarded the contract for a 300 gallon per minute centrifugal pump, 40 hp. semi-Diesel engine and a waterworks system, to include 150 gallons per minute motor driven centrifugal pump, to G. W. Kemper, Minot, N. D. Total estimated cost, $96,269.

Mo., St. Louis—The Board of Public Service has awarded the contract for installing a steam heating system in the proposed 4 story, 54 x 125 ft. hospital, to the Peters-Eichler Heating Co., 1516 Pine St.; electrical work to the Guarantee Electric Co., 1305 Pine St. Estimated cost, $11,997 and $4864, respectively.

Mo., St. Louis—The Schultz Belting Co., 4th and Barton Sts., has awarded the contract for the construction of a 1 story, 40 x 70 ft. belt factory and power plant, to J. W Cowper, Fidelity Bldg., Buffalo, N. Y. Total estimated cost, $15,000.

Mn., St. Louis—H. J. Wise, Engr., Post-Dispatch Bldg., has awarded the contract for the erection of a one story boiler house, etc., to William Voepel Co., 1113 Sidney St., for A. J. Feuerbacher, 1745 South 18th St., c/o Superior Laundry Co. Total estimated cost, $80,000. Noted Sept. 3.

Okla., Oklahoma—The city has awarded the contract for the installation of a fan blast air circulation heating and plumbing system in the Putnam Heights, Lowell, Hawthorne, Willard and Wheeler Schools, to Cook & McDonnel Co., 708 Herkovitz Bldg., $54,640.

A Personal Want—
can invariably be filled by a friend.

A Business Want—
must be satisfied by someone in your industry.

The Searchlight Section of this issue covers the current business wants of the machinery field

SEE PAGES 86 to 96

"Think SEARCHLIGHT First"

SEE PAGES 86 to 96

POWER

Volume 50 New York, September 16, 1919 Number 12

Candid Chats

The Human Element

THE PERSONAL relation of the chief to his men controls *the human element*. If you daily parade your authority as chief and form the habit of using the pronoun "I" instead of "we" it won't take your men long to form the opinion that you are autocratic, and antagonism will be the result. Working with your men gives an atmosphere of fellowship and creates good will.

Perhaps one of the greatest detriments to teamwork and plant harmony is the frequent issuing of harsh and perëmptory orders. Put your wishes in the form of suggestions or instructions. When you see that certain things can be done in a better way, make the suggestion that it be tried, thus leaving the men a chance to offer improvement of the plan.

Treat the men as individuals. When you use them as a part of the plant machinery you only succeed in submerging their individuality and likewise their initiative and progress. *The human element* is most vital in the maintenance and success of the plant, and any treatment that minimizes this important element is bad for you and for the business. If your plant force is small it is easy for you to personally know each one of your men, and in your contact with them, a "Hello, Frank, how's that youngster getting along?" gives a human-interest touch and cements the bonds of plant fellowship, shows the man that you are interested in him and makes it an easy thing for you to adapt him to your ideals.

When the plant organization is so large that this personal touch is not possible you can easily pick for your staff those who are in sympathy with your own ideas and delegate to them your authority. But after you place this responsibility upon their shoulders, don't tamper with their work, for if you change their orders to their men, etc., it is but a confession that you do not trust their abilities. You must consider them equal to their jobs or replace them with men whom you do. Give full authority to each department head to do as you would do; let the feeling be that plant success is a matter of common purpose.

Your office duties even as chief or superintendent of a large plant should never absorb your time to such an extent that frequent trips through the plant are impossible. Make it a point to know each engineer and department head as well as the leading men, and mingle enough with the oilers, firemen, coal passers and repairmen so that they will at least know you and get plenty of chances to form an opinion of what the big boss looks like. This will be a point in your favor, too. You must be a real personality to them and not a mere name.

Contributed by Charles H. Willey

Low-Pressure Turbines in Forge Shops*

By H. V. SCHOEPFLIN†

Economy of utilizing exhaust steam from hammers instead of wasting it to the atmosphere. Details of apparatus required and problems to be considered in the application.

THE same principles that make the turbine using high-pressure steam an economical machine apply to the turbine receiving its steam at about atmospheric pressure and exhausting to condenser vacuum. In the low-pressure section of a steam turbine a proportionately greater percentage of the available heat energy is actually converted into work than in the high-pressure section because of the lesser friction and leakage losses. The low-pressure portion of a high-pressure condensing machine may be built either into the same cylinder with the high-pressure, or in a separate cylinder receiving its steam from the high-pressure cylinder through a suitable connection. The principle is exactly the same as that of a compound reciprocating engine with the added advantage of the turbine being able to utilize to greater advantage the high vacua obtainable with modern condensing apparatus. It makes no difference whether the low-pressure turbine receives its steam from a high-pressure steam turbine with which it may be compounded, from a reciprocating engine or from any other source from which steam may be obtained at or about atmospheric pressure.

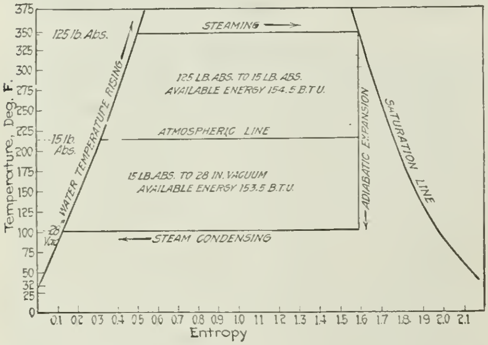


FIG. 1. TEMPERATURE-ENTROPY DIAGRAM SHOWING ENERGY AVAILABLE ABOVE AND BELOW THE ATMOSPHERIC LINE

Thus it will be seen that the low-pressure steam turbine is well adapted for the conversion into useful work of the large amounts of exhaust steam usually wasted in a drop-forge plant using steam hammers. This exhaust steam contains a much greater amount of available power than may be realized at first thought. Nearly as much heat energy is available in the expansion of a pound of steam from atmospheric pressure down to a vacuum of 28 in. of mercury as in an expansion from a pressure of 125 lb. abs. to atmospheric. A comparison between the heat energy available above and below atmosphere is graphically shown in the temperature-entropy diagram, Fig. 1.

Inasmuch as a great many forge shops at the present time are using boiler pressures of about 125 lb. gage, this pressure has been used in the diagram. The area of the space above the atmospheric pressure line, marked 125 lb. abs. to 15 lb. abs., represents the heat energy available for use in the hammers, figuring on a pressure drop from the boilers to the hammers of 15 lb.; and the area below this line, marked 15 lb. abs. to 28 in. vacuum, represents the available energy wasted if this steam is being discharged to the atmosphere. Inasmuch as the steam hammer is as a general rule a wasteful and inefficient heat engine in itself and the steam turbine the direct opposite, the proportional waste of energy is greater than shown by the diagram. The power may be generated in either the mechanical or electrical form and used for any purpose required.

When it is desirable that this waste energy be recovered, the first requirement is to provide proper means for collecting all the steam exhausting from the hammers. In most existing forge shops where any considerable number of steam hammers are in use, a portion of the exhaust is utilized in feed-water heaters or other boiler-room auxiliaries or for heating, and where such is the case the usual arrangement is to exhaust all the hammers into a common header or steam pipe of the proper diameter. This header performs the functions of a receiver of fairly large capacity, from which the steam to be utilized is taken and the remainder discharged to the atmosphere through a relief valve. When installing a turbine where this arrangement is in use and the conditions are such as to make it desirable, the existing exhaust piping can be used without any great amount of rearrangement, provided the size of the main header and the branch lines is sufficient to keep the pressure drop down to a reasonable amount. The turbine may then receive its supply of steam directly from the header with the interposition of a constant-pressure valve to keep a uniform back pressure on the hammers. Atmospheric relief valves are provided in the exhaust line as before, which valves open only when the exhaust-steam supply becomes greater than that required.

From the header the steam, after having the moisture and foreign matter separated from it, is supplied to a low-pressure turbine through a throttling-type valve controlled by the turbine governor. This valve regulates the steam supply in proportion to the load requirements and maintains a practically constant speed. The percentage of available energy recovered from the exhaust steam of course depends upon the efficiency of the turbine.

As important as the turbine itself is, it is the condenser with its auxiliaries which make possible the entire application. By referring again to the temperature-entropy diagram, the reason for this becomes obvious, as it will be seen that if the line representing steam condensing is moved down to a lower point of absolute pressure, the area of the space below the atmospheric line immediately becomes greater, which

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[*] Abstract of paper read before the American Drop Forge Association, Pittsburgh, Penn.

[†] With the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Penn.

means that a greater amount of heat energy is available per pound of steam.

In the low-pressure header the use of some form of constant-pressure valve is made necessary by the fact that with any type of turbine the inlet pressure at light loads is below atmospheric, and as it is highly undesirable to have a vacuum in long large lines such as the steam hammers exhaust into, some means must be provided for preventing such a condition. Without it the back pressure on the hammers would vary considerably as the load on the turbine varied, and at times this back pressure would be below atmosphere so that air would be drawn into the header through leaky flanges and pass through the turbine into the condenser to reduce the vacuum.

A constant-pressure valve adapted to this class of work is shown in Fig. 2. It comprises a piston-type valve operated by the pressure in the header. The top of the piston is open to the atmosphere and the bottom to the pressure in the header. If this pressure rises above that for which the valve is loaded, the valve will of course lift and the opening for flow increase. If the header pressure falls below that for which the valve is loaded, the valve will drop until the area for flow has decreased a sufficient amount to restore the pressure balance. If the exhaust-steam supply fails entirely, the valve will close, shutting off the turbine and condenser from the header.

Fig. 3, a longitudinal cross-section of a low-pressure turbine, shows the path taken by the steam through the blading. This particular turbine is of the double-flow reaction type, the blading being so arranged that the steam, after entering the central portion of the cylinder, divides and flows in opposite directions through separate groups of blading to the exhaust chambers, whence it is carried to the condenser through a Y-connection. The blading is made up of alternate stationary and moving rows of what is known as reaction blading, and the flow of steam through this blading is equal in each direction, as shown by the arrows in the sectional view. The turbine is not limited to the double-flow type, but may be built also with the flow of steam in one direction and with one exhaust nozzle, provided the desired capacity and speed will permit.

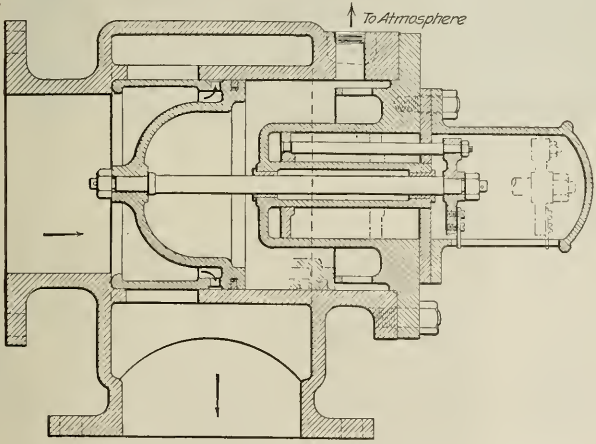


FIG. 2. SECTIONAL ELEVATION OF CONSTANT-PRESSURE VALVE

The governor is of the flyball type and operates the admission valve or valves through an oil relay system. The sectional view, Fig. 4, shows the construction of the governor and the relation of the various parts. The governor spindle is gear-driven from the turbine shaft, and as the centrifugal force of the weights is dependent upon the speed, the spring is proportioned for the range of turbine speed desired. The motion of the governor weights changes the position of the clutch, which is connected by a system of levers to a relay valve. This relay valve controls the admission of oil at a pressure of approximately 50 lb. to the operating cylinder which opens or closes the admission valve. The effect of a change in the position of the weights therefore changes the position or opening of the main valve, thus regulating the inlet of steam in accordance with the demands of the load.

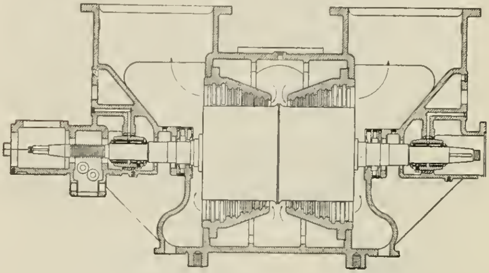


FIG. 3. SECTION THROUGH DOUBLE-FLOW LOW-PRESSURE TURBINE

Where the amount of exhaust steam available varies, there is usually incorporated, in addition to the low-pressure steam valve, an auxiliary live-steam admission valve, which is also under control of the governor. This arrangement precludes the possibility of the generating capacity of the turbine being reduced or entirely lost owing to a deficiency in the supply of exhaust steam. The general construction of a steam chest which is adapted for use with low-pressure turbines and which includes an auxiliary valve for the admission of high-pressure steam is shown in Fig. 5. The operating cylinder is under control of the governor through the medium of a high-pressure oil relay system, both valves being under governor control as they are lifted in turn by the single main operating lever attached to the rod of the oil-operated piston. Adjustment of this mechanism is made so that the live-steam valve does not open until the maximum load that can be carried on low-pressure steam alone is reached. The auxiliary valve thus allows the unit to adapt itself to any condition, even to the extreme of generating full rated load on live steam, the steam economy during such operation being between 8 and 10 per cent. better, depending upon the pressure, due to the superheat resulting from throttling the live steam.

In brief, the lubricating system that is generally employed, consists of a supply reservoir, surge tank and oil pump driven from the governor spindle by spur gearing, a cooler built like a surface condenser and a strainer to remove foreign matter.

For this kind of service the jet type condenser is favored as there is less difficulty experienced by reason of oil or foreign matter being contained in the steam.

For the attainment of maximum conditions of efficiency when planning an installation of this character, the following considerations are taken into account:

1. Continuity of flow and amount of exhaust steam available exclusive of that used in auxiliaries, for heating, or other uses.

2. Electrical load. Not only must the present demand for electrical energy be taken into account, but also the possibilities for further use of electric power over and above the present demand, provided a sufficient amount of exhaust steam is constantly on hand for producing this increased amount of energy. In other words, it is highly desirable to obtain as nearly as is possible a balance between the latent energy present in the steam being wasted, and the electrical-load requirements that can be met by making use of this steam.

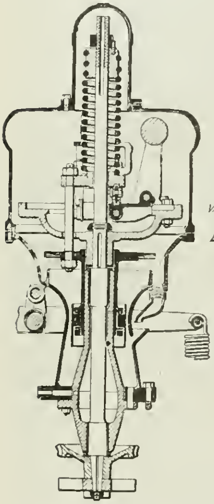


FIG. 4. GOVERNOR OF LOW-PRESSURE TURBINE

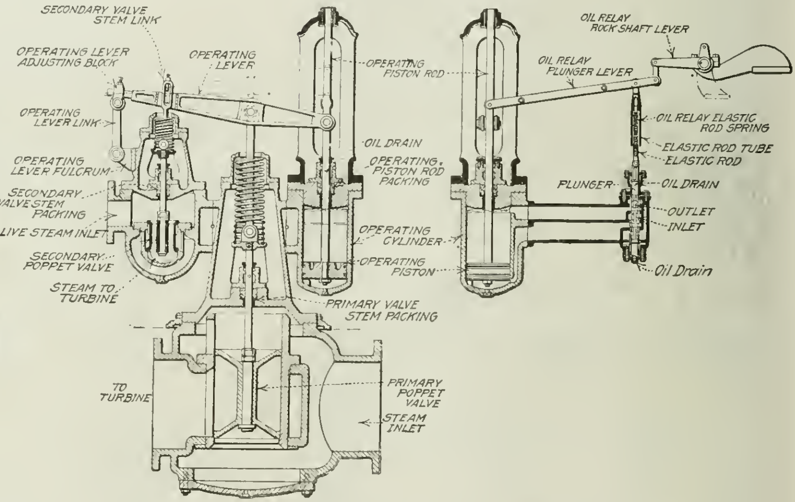


FIG. 5. ADMISSION VALVES FOR HIGH- AND LOW-PRESSURE STEAM AND OPERATING MECHANISM

3. Water supply for the condenser is of great importance, as to obtain the best economy the low-pressure turbine must be exhausted to the highest possible vacuum, and this requires an ample supply of clean, pure water at a low temperature.

Every plant is more or less a separate and distinct problem in itself, but it is safe to assert that a great improvement in plant efficiency with comparatively little outlay may be secured in any forge shop where the exhaust from as many as eight or ten steam hammers in constant operation may be used for driving a low-pressure steam turbine. Take, for instance, a plant where ten hammers are in constant operation and assume that these hammers (varying in size from 800 to 5000 lb. falling weight) have an average steam consumption of 2000 lb. per hour each. Assuming that the moisture contained in this steam is about 10 per cent. of the whole, a total of 18,000 lb. of dry steam per hour is available for use after the moisture has been properly separated. From this amount of steam approximately 500 kw. of electrical energy may be obtained per hour by the use of a properly designed exhaust-steam turbine. If the plant in question had been using previously about this amount of power and had purchased it from a local central station at a cost of, say, 2c. per kw.-hr., the power generated by the turbine would be worth $10 per hour or $1 per hour for each steam hammer in the plant, and would be obtained without additional consumption of fuel. Against this saving would, of course, be charged the interest and depreciation on the original investment, slightly increasing operating costs and other standing charges, all of which might vary considerably in amount, depending upon local conditions.

In one forge shop, where a low-pressure turbine had been in operation since March, 1917, and the steam supply had been obtained from an average of 13 hammers running continuously ten hours per day excepting Saturdays, the average amount of electrical energy obtained was about 2700 kw.-hr. per day and the capacity of the turbine 300 kw. Only 40 per cent. of the exhaust steam was used by the turbine and a small percentage used in the heating system and for heating boiler-feed water. No increase in the coal consumption had been observed since the unit was installed, and at the prevailing cost of electricity the saving was estimated as $8000 per year. The boiler pressure in this plant averaged 135 lb. gage, and a back pressure of 10 lb. gage was maintained in the low-pressure header, the turbine exhausting to a vacuum of 27 in. of mercury referred to a 30-in. barometer.

In cases where the electrical load demand is greater than can be taken care of by the amount of exhaust steam constantly available, a turbine of the mixed-pressure type, Fig. 6, may be employed. In this turbine both high-pressure and low-pressure admission valves are used, but the high-pressure valve admits steam through a set of nozzles to a turbine which is of the impulse type. The high-pressure steam expands to a pressure below atmospheric and imparts its energy to the impulse wheel, the low-pressure steam being introduced at the entrance to the reaction blading. All low-pressure steam is thus put to work and only a sufficient amount of high-pressure steam used to make up the deficiency in load.

In the foregoing the conversion of the heat energy in the exhaust steam into electrical energy only has been discussed. It must be remembered, however, that this latent energy is convertible into power, and with reduction gearing this power may be obtained in various forms. Without the use of reduction gearing the modern steam turbine may be used for the generation of alternating current, and by means of suitable gears may be adapted for driving direct-current generators, reciprocating or centrifugal pumps, mill drive, or for almost any conceivable purpose where the driven apparatus must run at a comparatively slow speed, and the turbine may still be allowed to operate at its most efficient speed.

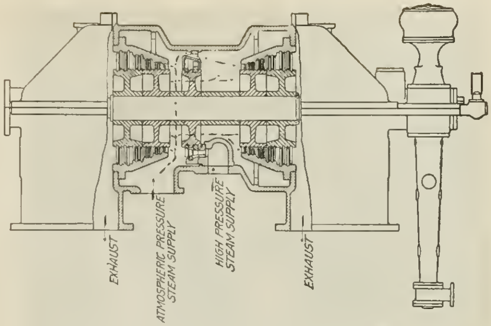


FIG. 6. MIXED-PRESSURE TURBINE

The balance of the paper was devoted to methods of increasing the electrical load to fully utilize the exhaust steam, and the removal of water, foreign matter and oil from the steam supply.

Winton Diesel Oil Engine

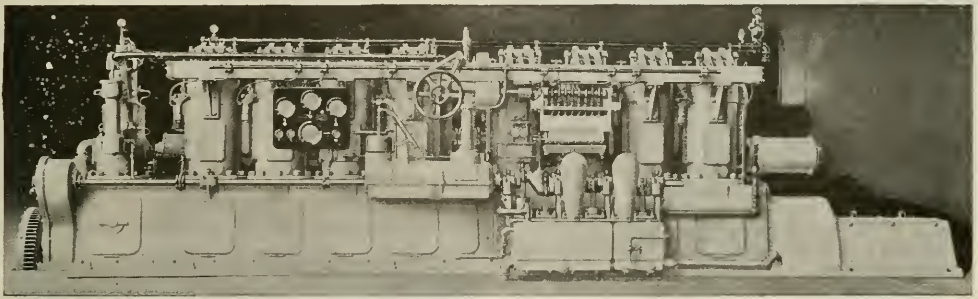


FIG. 1. SIDE VIEW OF THE WINTON DIESEL OIL ENGINE

THE Winton oil engine of the full Diesel type, which formerly was used in the marine field, is now built for stationary service for direct connection to generators (Fig. 1), pumps, etc., or it can be built for belt drive. There are three sizes of the stationary engines with three, four, six and eight cylinders and developing from 50 to 450 horsepower. Inclosed crank cases, trunk-type pistons and crankshaft bearings solidly mounted in the upper half of the crank case with bolted-on-caps are the chief characteristics of this engine, which is manufactured by the Winton Engine Works, Cleveland, Ohio.

The fuel pump, Fig. 2, is of the plunger type, with one plunger for each cylinder. It delivers the fuel to the fuel-injection valve under a pressure of from 1000 to 1200 lb., depending on the pressure of the fuel-injection air. The stroke of the fuel pump is constant, the amount of fuel delivered being controlled by the early or late closing of the pump-inlet valve by the governor. The fuel oil is lifted from the tank to the fuel pump by 10 to 15 lb. air pressure.

The fuel is forced into the cylinder against a compression of 550 lb. by the use of air at about 1000 lb. pressure, which is obtained from a three-stage air compressor mounted at the front end of the engine.

The compressor piston is of the trunk type and is operated by a connecting-rod and a single-throw counterweighted crankshaft bolted to the front end of the main crankshaft. The throw of this single crank is somewhat greater than that of the power shaft.

The capacity of the air compressor, being considerably in excess of that required for the injection of the fuel, provides for the initial charging and maintenance of pressure in the storage tanks, or air bottles, which are used for starting the engine. There are two sets of these air bottles, one carrying the air at about 600 lb. per sq.in. for starting, the second set carrying air at 1000 to 1200 lb. per sq.in. for fuel injection.

The crank case is cast in one piece, of skeleton construction, the sides having large covered openings opposite each throw of the crankshaft. A crankshaft bearing is provided on each side of each throw. The lower part of the crank case forms an oil pan, which extends from the timing gear in the front to the rear of the thrust bearing at the back end of the engine, thus giving a fully inclosed oiling system.

The cylinders are cast individually, with integral water jackets. Large cover plates on the water jackets permit of ready cleaning. Each cylinder head carries five valves—two for the incoming air, two for the exhaust and one for the injection of the fuel. The head also carries the rocker mechanism by means of which

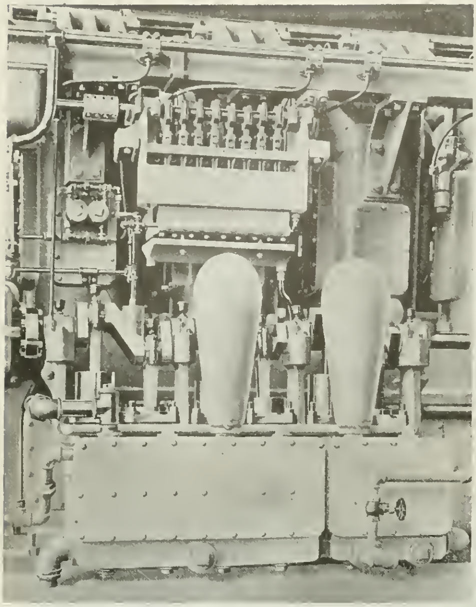


FIG. 2. OIL PUMP AND FUEL PUMP OF THE WINTON DIESEL OIL ENGINE

these valves are operated. The pistons are about 75 per cent. greater in length than in diameter and the piston-pin bosses are located about one-third of the diameter up from the bottom of the piston, which brings them about the center of the effective bearing surface.

A groove is turned immediately below the lowest ring to prevent oil working up above the piston rings, and from this groove a number of holes lead back into the inside of the piston. To prevent oil splashing up under the lower side of the head, the hole through the rib around the inside of the piston is inclosed by a sheet-metal plate.

Each piston rod has an oil tube connecting with the groove in the upper half-box and leading upward to the hollow piston pin, with its end plugged, and is drilled near each end so that oil is fed to the bushings in the piston.

The crankshaft is made in three pieces, two sections having each three or four throws for the power cylinders, and the third section having a single throw for the air compressor.

From each main bearing of the shaft a hole is drilled through the adjacent web of the crankpin. These holes register with grooves in the main and connecting-rod bearings so that the connecting-rod lower bearings are also lubricated under pressure directly from the pump. Each bearing has an individual oil lead to a header running the full length of the crank case. This header is connected to a two-cylinder reciprocating oil pump which maintains constant oil pressure on the bearings.

The camshaft is supported in a long box-shaped casting open at the top. This trough is partly filled with oil, which lubricates the cams and camshaft bearings. The driving gears are fed directly with oil under pressure from the pump.

The camshaft is provided with two sets of cams, for forward and reverse motion respectively. Shifting the shaft endways by means of a handwheel and suitable mechanism brings either set of cams into operation. This is frequently accomplished in five seconds.

In Fig. 3 is shown an assembled cylinder head with valve-operating mechanism and fuel-injection pipes. Each pair of inlet and exhaust valves is operated from the camshaft by a single rocker arm, the valves being connected by a T-head slide on which the end of the rocker rests. The slide is carried in contact with the rocker at all times by a coiled spring in the center of its hollow stem. These pairs of valves are used instead of single large valves, as the small valves are much less likely to warp under the high temperature to which they are exposed.

The fuel-injection valve is located in the center of the head (see Fig. 5) and is also operated by a rocker from the camshaft. The adjusting screw for this valve is set to leave 0.025 in. clearance when the valve is closed.

The valve timing, as regards the air inlet and the exhaust valves, is very close to an average four-cycle gasoline-engine valve timing, the figures being as follows: Air intake opens 5 deg. before upper center; air intake closes 25 deg. to 30 deg. after lower center; exhaust opens 40 deg. before lower center; exhaust closed on top center.

The timing of the fuel injection valve is as follows: Valve opens 7 deg. before upper center; valve closes 25 deg. after upper center.

High pressure-injection air flows all the time the injection valve is open. Fuel is injected, however, during part or all of this period, depending on the amount of power required from the engine. The amount of fuel is controlled by a centrifugal governor which limits the duration of the fuel-pump suction.

Cooling water is circulated through the jackets of the

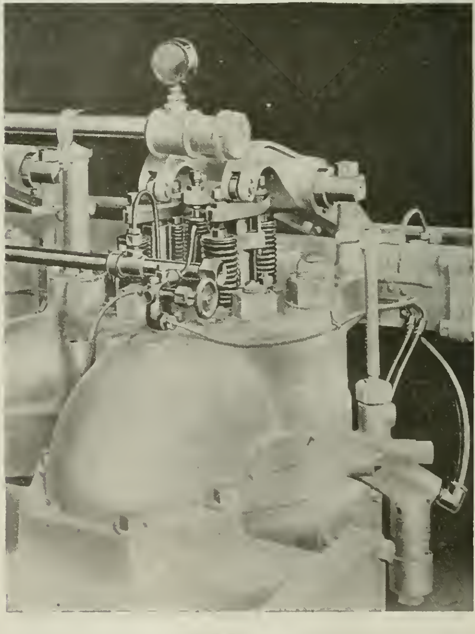


FIG. 3. ASSEMBLED CYLINDER HEAD SHOWING VALVE OPERATING MECHANISM AND FUEL INJECTION PIPES

engine cylinders and the air compressor by a four-cylinder plunger pump operating from the same small crankshaft which handles the oil-circulating pump.

The oil-circulating system, which provides lubrication for all the main bearings of the engine, is supplied by two single-cylinder pumps. The one driven from the end throw of the crankshaft operating the circulating water and lubricating oil pumps draws the oil from the well in the lower half of the crank case and forces it through a cooler and a strainer to a storage tank. The other pump draws the oil from this storage tank and forces it into the header, from which it is piped to the bearings. The circulating-water pump is of the four-cylinder type and also has an air chamber on the discharge side to insure steady circulation of water. The cylinders, pistons and stuffing-box glands are made of bronze to prevent injury by the water. An end sectional elevation of the engine is shown in Fig. 4.

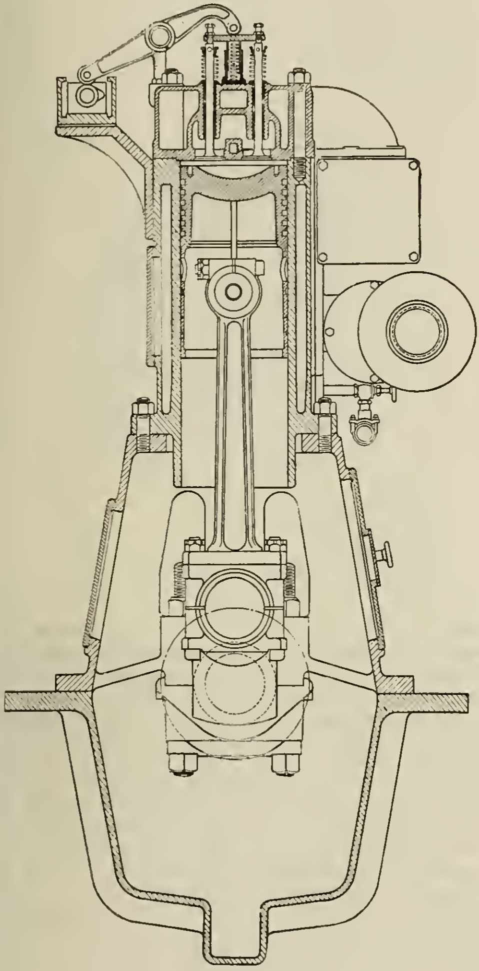


FIG. 4. SECTIONAL ELEVATION THROUGH THE WINTON ENGINE

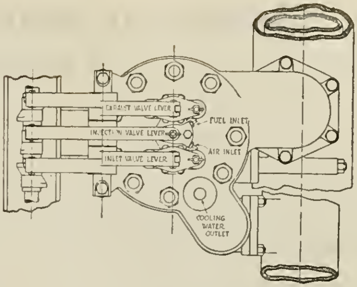


FIG. 5. TOP PLAN SHOWING LOCATION OF VALVES

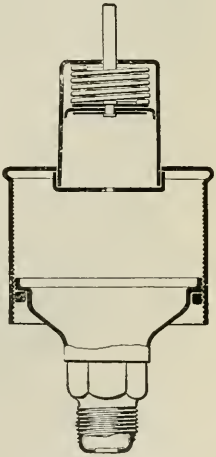
Pressure delivered by the air compressor is as follows:

High-pressure cylinder..........	1050	1200	1175	1150	1225
Intermediate cylinder............	200	295	280	280	325
Low-pressure cylinder...........	60	60	60	60	60

The camshaft runs one-half the engine speed and the oil and water pumps two-sevenths of the engine speed.

New Standard "Duplex" Grease Cup

The New Standard "Duplex" grease cups embody a departure from the usual method of feeding grease, making the use of fluid pressure instead of the ordinary spring pressure. The cup is in two parts with a diaphragm between, in which is a small hole through which the grease passes into and out of the top portion, or feed chamber. This contains a spring-actuated plunger with a stem that protrudes through the top and serves as a sight-feed indicator. Thus the plunger is acted upon by a spring pressure above and a fluid pressure below, and the grease moves alternately in the direction of the stronger force. When the lower portion, or reservoir, is filled with grease and screwed down on the base, the fluid pressure thus created drives grease through the diaphragm, raises the plunger and sets the indicator, and at the same time drives grease through the shank, in contact with the bearing. As the bearing uses up the grease, other grease automatically takes its place, the feed pressure being simply sufficient to keep a column of grease in constant touch with the bearing. In the "Duplex" cup the feed chamber can be filled from four to ten times for each filling of the reservoir cup, according to the size of the latter; but in the "Auto-Twin-Cell" cup the feed chamber and the reservoir have the same capacity, so that the cup may be screwed down as far as it will go, driving all the grease into the feed chamber, setting the indicator and at the same time jam-locking the cup to the base against jarring off. Both cups, which are manufactured by the Standard Manufacturing and Sales Co., 1325 Arch St., Philadelphia, Penn., have fiber washers to prevent leakage of grease, and in both the height of the indicator always tells the amount of grease in the feed chamber.



DUPLEX GREASE CUP

Methods of Synchronizing Alternating-Current Machines

By FRANK GILLOOLY

The construction and principles of operation of the different types of synchronoscopes are described and various methods of synchronizing alternating-current machines discussed.

BEFORE alternating-current generators may be paralleled, their frequencies must be the same and their voltages equal and in phase; in other words, they must be in synchronism. The same thing applies to large synchronous motors or converters—in fact, to any rotating synchronous apparatus that is not self-starting.

The earliest method used to determine the condition of synchronism was by connecting lamps in series between the machines being synchronized. The lamps were connected between like terminals of both machines, Fig. 1, if synchronizing was to be done with the lamps dark: and between opposite terminals, Fig. 2, for synchronizing with the lamps bright. The lamps in either case indicated by their degree of brilliance the voltage difference between the machines. The lamps on high-voltage machines are connected through potential transformers, with a set of lamps for each of two or three of the phases. In addition to synchronizing, the lamps are utilized for phasing out the alternators. The connection whereby the lamps are bright at synchronism, which was designed to prevent a wrong indication by reason of one of the lamps being burnt out, is now rarely used.

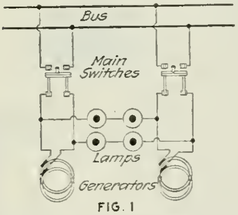


FIG. 1

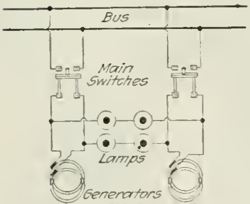


FIG. 2

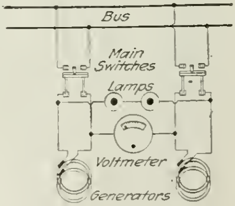


FIG. 3

FIGS. 1 TO 3. SYNCHRONIZING CONNECTIONS FOR LAMPS AND VOLTMETER

Lamps are unsatisfactory for synchronizing because they can do nothing more than to indicate a difference in voltage above that value required to glow their filaments. Voltmeters have been substituted for lamps, as in Fig. 3, but while they indicate any voltage difference, they do not show the relative speed of the machines or the phase angle between them. Only in the synchronoscope—synchronism indicator—are all these desirable features combined.

Whatever style of synchronoscope is used, the generator switch is closed when the synchronizing instrument's pointer is traveling slowly and is close to the zero. A more or less violent disturbance will be produced in the incoming and running machines if the switch is closed when the machines are not in synchronism, depending on how far the incoming machine is out of phase. This disturbance is slight if the switch is closed when the synchronoscope is rotating slowly in the "fast" direction and is approaching zero. The effect of closing the switch when the machine is "fast" and past the zero mark is to make it take a large percentage of the load, the amount of which will depend upon and be due to the machine's advance in phase angle over the running machines. If the incoming machine is "fast" but has not reached zero when the switch is closed, the other machines will easily pull it into step—a condition toward which it was moving. Should the incoming machine be running "slow" and the switch is closed when the synchronoscope pointer has passed zero, the disturbances will be heavy, since the other machines must reverse the direction of the former's phase angle in order to pull it into step. If the incoming machine is "slow" and approaching zero, the disturbance will not be so great, though more severe than if it had been rotating "fast." In each of these four cases a rush of synchronizing current will occur between the armatures of the machines until the incoming generator has been pulled into step. The effect of closing the switch with the incoming machine's voltage different from that of the bus is to cause armature cross-current to flow between the machines, due to the unequal fields.

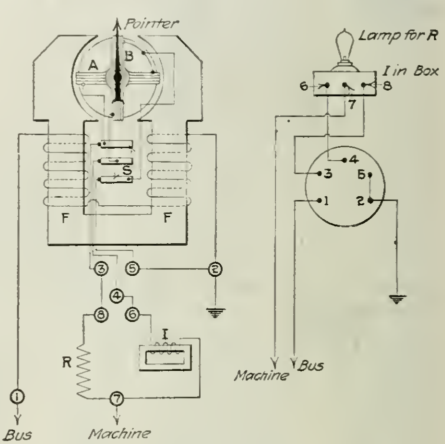


FIG. 4. SCHEMATIC DIAGRAM OF LINCOLN SYNCHRONOSCOPE

There are a number of makes of synchronoscopes, or synchronizers. The Lincoln type, manufactured by two different companies, operates on the rotating-field principle, the speed of the moving element representing the difference in frequency between the two circuits being synchronized. In the stationary position of the moving element, at any instant, the angle between its pointer and the zero point on the scale represents the phase angle between the two circuits.

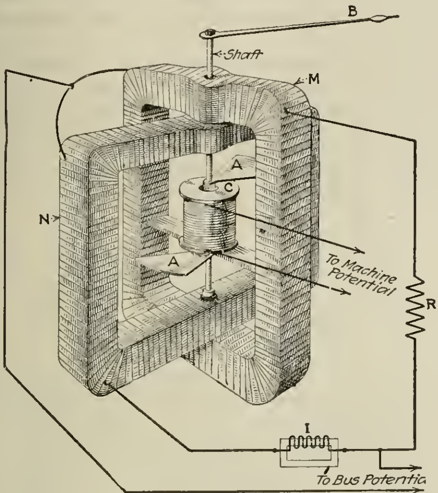


FIG. 5. SYNCHRONOSCOPE SIMILAR TO FIG. 4 BUT HAVING ALL COILS STATIONARY

The Lincoln synchronoscope, Fig. 4, is essentially a bipolar, split-phase, synchronous motor operating on the difference in phase between the machines being synchronized. Its two field coils, F and F, are connected in series across one phase of the bus, or the running machine, consequently excited with alternating current instead of direct current. Its two armature coils, A and B, located at an angle of 90 deg. to each other, are connected in parallel through slip rings and brushes S to the corresponding phase of the incoming machine. The armature and field cores are of laminated iron.

One armature coil A has a resistance R in series with it, the other coil B has an inductance I in series with it; causing the current in B to lag behind the current in A by approximately 90 deg., thus producing a rotating field in the armature core which, when acted upon by the alternating field of the field circuit FF, causes the armature to assume the position where its lines of force coincide with those of the field. As this point changes the armature rotates with it. Since the current in the field coils lags the voltage across them by nearly 90 deg., and the current in the armature coil B, due to the inductance in series with it, lags the voltage across it by approximately 90 deg., at exact synchronism B will be in the position where its field will be parallel to the field of FF. This position of the armature at synchronism brings its pointer to the vertical position, as shown in Fig. 4, corresponding to the indication on a clock at the hour of twelve. The indicator rotates clockwise when the incoming machine is "fast" and counterclockwise when the incoming machine is "slow."

Another type of synchronoscope operating on the same principle is shown diagrammatically in Fig. 5. The moving element consists of two vanes, A and A, on either end of a cylindrical iron core in the center of the fixed coil C and fastened to the shaft carrying the pointer B. The rotating field is produced by the two stationary coils M and N situated 90 deg. apart and connected in parallel, M through a resistance R and N through an inductance I.

The vanes are excited alternately positive and negative by the alternating field of coil C and are deflected by the fields of coils M and N. Coil M has its current in phase with that of C and deflects the vanes so as to parallel the field of M with that of C. Coil N, with the inductance I in series, has its current lagging that of C by approximately 90 deg.; and so long as this phase relationship is maintained—which is the point of synchronism—it exerts no torque on A and A. At any other angle of phase between N and C, N will deflect the vanes; and with a difference in frequency between machine and bus a varying torque will be produced that will rotate the shaft.

In this instrument the rotating field is produced in the split-phase winding by the bus potential and the alternating field by the machine potential—an arrangement opposite to that of the Lincoln instrument, Fig. 4. Hence, the indicator's direction of rotation is counterclockwise when the incoming machine is "fast" and clockwise when the incoming machine is "slow."

The synchronoscope shown in Fig. 6 operates on the electrodynamometer principle, in which the torque exerted on a movable coil A, suspended between two stationary coils F and F, is opposed by spiral control springs. The stationary coils F and F are connected in series through the resistance R_F across the bus or running machine. The movable coil A, carrying the pointer, is connected in series with a condenser C and a resistance R_A, across the machine to be synchronized. A 90-deg. phase displacement is thus obtained by making the current in A lead that in F and F by means of the condenser.

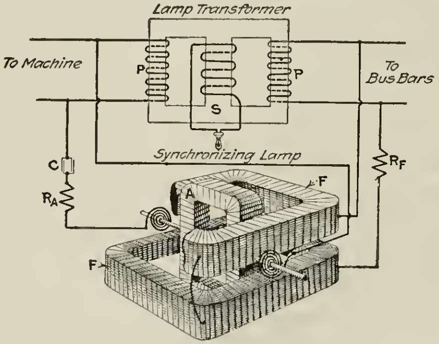


FIG. 6. SYNCHRONOSCOPE OPERATING ON THE ELECTRODYNAMOMETER PRINCIPLE

At exact synchronism—the true 90-deg. phase angle between the movable and stationary coil circuits—no torque is exerted on A, and it is held at zero position in the center of scale by the control springs. A difference in frequency between the machines will produce a varying torque, and A will oscillate the pointer back and forth on the scale. If the frequencies of machine and bus are equal but there is a difference in phase, A will take up a position of balance along the scale corresponding to this phase angle. Right and left of the zero, central, position of the scale are "fast" and "slow" respectively with regard to the machine. The pointer merely oscillates back and forth on the horizontal scale instead of rotating over a circular dial. The dial is illuminated by one lamp connected to the secondary S of a transformer having two primaries P and P, connected one across the incoming machine and the other across the bus, and is bright at synchronism.

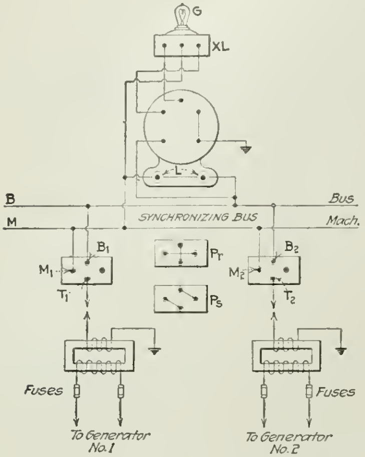


FIG. 7. DIAGRAM OF CONNECTIONS FOR LINCOLN SYNCHRONOSCOPE

Each revolution of the synchronoscope pointer represents one cycle difference in frequency between the alternators. The deflection of the pointer from zero at any instant represents the phase angle between the machines. This last function of the synchronoscope is utilized in the paralleling of frequency changers, so that they may take their share of the load, after the two systems on which they run have been locked in step and speed regulation on the individual frequency changers is impossible. A separate synchronoscope is provided for both motor and generator of the set. The motor's switch is closed when its synchronoscope indicates zero and the generator's switch is closed when its synchronoscope indicates the advanced phase angle calculated to make the generator take up a specified amount of the load.

The foregoing requires fine synchronizing. The operator here has two synchronoscopes to watch. With a 60-cycle to 25-cycle frequency changer (the usual type) if the proper synchronizing point is missed the operator must wait twelve revolutions on the 60-cycle synchronoscope and five revolutions on the 25-cycle synchronoscope—the ratio in whole numbers of the two frequencies, 60 to 25, or 12 to 5—before the desired combination again appears. Charts are usually provided, showing the indications on both synchronoscopes one revolution before the motor switch is closed.

The synchronoscope is not intended to be kept energized when not in use or to be revolved at too great a speed. Where synchronizing lamps are provided, the speed of the alternator should be adjusted closely by them before the synchronoscope is plugged in circuit; if necessary, the synchronism indicator may be plugged in for a moment in order to determine whether the incoming machine is fast or slow. Just as the lamps can be checked against the synchronoscope when synchronizing, so should the instrument be checked against the lamps when phasing out apparatus. Suitable systems of plugs and receptacles permit of both operations, and through the phase-selector instrument switch, Fig. 8, likewise a part of the equipment of a modern switchboard, the synchronoscope can be connected in turn to both phases. Synchronoscope plugs now have an extra pair of contacts as shown at S_c in Fig. 8, through which the closing circuit of the remote-controlled oil switch is completed, in order to prevent the mistake of closing a wrong generator switch.

In Fig. 7 is shown a simple form of Lincoln synchronoscope installation that is frequently met with. The synchronizing bus runs to all generator panels. All receptacles are wired alike, to the same phase on each machine. One side of the generator potential transformers is grounded, the other sides are brought to the bottom terminals T_1 and T_2, of the receptacles. Two kinds of plugs are used: One, P_r, is inserted in the receptacle of the running machine, the other, P_s, in the receptacle of the incoming machine. The top connection, B_1 and B_2, of each receptacle goes to the conductor B of the synchronizing bus connected to the field coils of the synchronoscope. The third point of each receptacle, M_1 and M_2, goes to the conductor M of the bus connecting to the armature of the synchronoscope. The fourth terminal of the receptacle is not used with

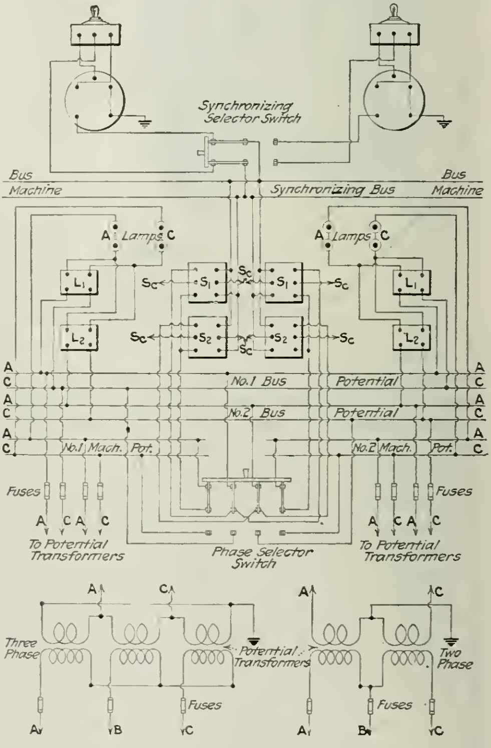


FIG. 8. DIAGRAM OF SYNCHRONIZING LAYOUT FOR A LARGE STATION

grounded secondary transformers. The inductance-resistance box is shown at XL, of which lamp G is the resistance. Lamps L are on the base of the synchronoscope and are connected so as to be dark at synchronism.

Fig. 8 shows a typical synchronizing layout of a large station. Here two synchronoscopes are provided, made selective from a double-throw, double-pole knife switch. The synchronizing is done between machine and bus and can be from either phase through the double-throw phase-selector switch. Potential transformer connections are shown for both two- and three-phase, three-wire systems. Primary and secondary fuses are located with the transformers in the bus structure. The synchronizing and bus-potential busses go to all generator panels. Each generator panel has, in addition its own machine-potential bus, to which are connected the pilot lamps, the voltmeter and the potential coils of the wattmeters and the power-factor meter. The generator oil switches cannot be closed unless the synchronoscope plug is in the proper receptacle, as the direct-current supply circuit to the closing element of the switch is open between the middle pair of contacts of the receptacle, as shown at S_c on each receptacle.

Phasing lamps, A and C, are provided on two phases of each generator and have a separate receptacle to each bus, L_1 and L_2. As the station has duplicate busses, two synchronoscope receptacles, S_1 and S_2, are necessary. The lamps are plugged in circuit before the synchronoscope, and the frequency of the incoming unit is adjusted close to that of the bus by speeding or slowing until the rate of change in lamp brilliance is low.

Any apparatus may be phased against the alternators by closing it on the bus not in use and inserting the plug in the lamp receptacle to that bus from one of the alternators on the line. The synchronoscope is checked against the lamps by plugging it in on the generator connected to the bus carrying the apparatus being tested, and both phases are thus checked by throwing over the instrument phase-selector switch. In large systems new high-tension apparatus is never put on the line until this phase-test has been made on it. Duplicate bus systems are now in use in all stations and substations of modern central-station systems.

Refrigerating Troubles in a Packing House Plant

By J. C. MORAN

Because of inadequate cooling coil surface chiefly, the plant of a packing house gave the crew no end of trouble. How the plant was put in good condition, paying the cost in six months on the saving in coal and water, is told in the article.

IT SEEMS peculiar, but it is a fact, that the average packing-house power plant is run "on a shoe string." Often it is a case of getting one piece of equipment fixed up at the moment another breaks down. Something is always going to wreck or refusing to work properly. Sometimes several machines go out of commission at once and then the whole works is tied up until a makeshift repair is made; generally the equipment is left in this condition until it lets go again. Consequently the average packing-house power-plant force is always on a hot stove or going to a fire, as it were. The particular plant in question was no exception to the general rule, and as is nearly always the case, the management had insisted on the cheapest possible installation when it was first built and refused to make any improvements until the service became so bad that something had to be done. This attitude on the part of packing-plant owners may be due to there being so much more greater returns on the money when invested in the manufacturing end of the business than the more moderate savings made by keeping the power plant up-to-date.

The plant was a little over two years old. They managed to pull through the second season without spoiling too much of the meat in the coolers; but during the winter business increased considerably and in the latter part of March it was impossible to keep the temperatures down with the machines running at top speed. It required no prophet to predict what would happen when the weather became warmer. It was at this time that the writer was called in.

The refrigerating equipment consisted of three horizontal double-acting compressors, atmospheric condensers, and direct expansion coils in all the rooms. The load came from two large chill rooms, two large storage coolers, a wholesale market of considerable size, three freezers and an offal cooler. The machines were of 40, 75 and 125 tons respectively and ran at 80 to 95 r.p.m.

The largest machine has been run only one season, having been installed when it was found that the other two could not carry the load. No more pipe had been added in the coolers, however, and when I came to check over this part of the equipment I began to understand why it was necessary to run the machines at this high speed to get the work done. To liberally provide the rooms there should be about three times more pipe. A liberal amount of piping is about one of the best investments that can be put into a refrigerating system.

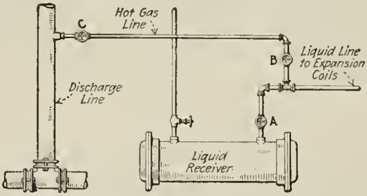


FIG. 1. HOT GAS CONNECTION TO DISCHARGE LINE

Nor was this all. About a gallon of oil went into the system every day, and the oil traps were blown about every two weeks. As a consequence the traps ran over most of the time and the system was loaded with oil. In addition, the frost had apparently never been removed from a number of the coils.

The first move was to order 40,000 ft. of 2-in. pipe for additional coils in the various rooms. The next was to make a hot gas connection from the discharge line of one of the compressors to the liquid line from the liquid receiver to the expansion coils. The connections are illustrated in Fig. 1. By this connection it was possible to turn hot gas direct from the discharge line into the expansion coils. By shutting off the valve on the suction end of the coils and opening the liquid or expansion valve wide this hot gas passed direct from the discharge line through valves *C* and *B* and the expansion valve at the coil directly into the same, where it began to condense and heat the coil, just as in a condenser, except that heat was taken up by the frost on the coil. While operating in this manner, the valve *A* had to be closed; the other coils supplied from this liquid line had to have their expansion valve shut off, with the exception of the one being cleaned.

This loosened the frost on the coils and in about three days every coil was clean. Now we could slow the machines a little and still hold the temperatures. Of course the outside temperature was not very high, still it was warmer than it had been the week previous when all the machines had been run at top speed, and yet the cooler temperatures had been 15 to 20 deg. F. too high. We drew off from the traps more than a large pailful of oil every day. No oil was used except on the lanterns in the stuffing-boxes.

The greatest trouble was experienced in the chill rooms for the beeves and hogs. I don't remember the figures, but when the pipe arrived we put in a little over double the amount the coolers originally had, giving them over three times as much pipe as they originally contained. While this gave a liberal amount, it was not high as compared with the best practice.

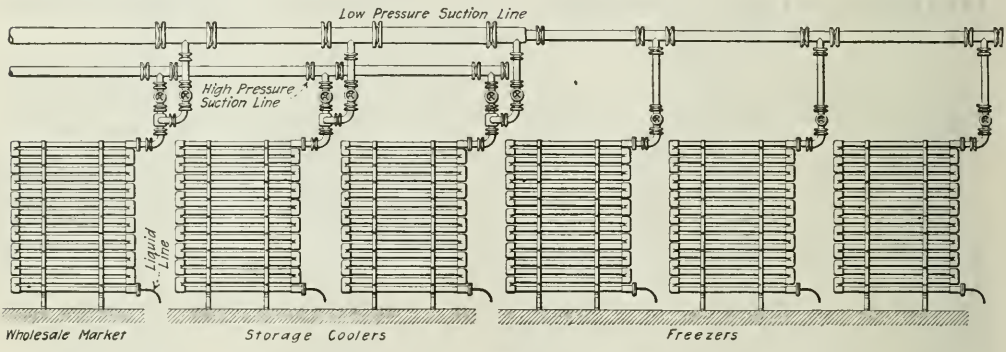


FIG. 2. SHOWING SUCTION-LINE CONNECTIONS TO THE VARIOUS COOLING COILS

When these new coils were cut in the chill room temperatures came rapidly down. To show what they would do I arranged the work so that we cut them all in one Saturday night. Sunday and Sunday night a gang was working with air and a steam hose to thoroughly blow the oil out of the old coils. Monday afternoon everything was cut in and towards evening when the coolers had a full load, everything was working fine. About 1.00 a. m. Tuesday the beef cooler had come down to 34 deg. and the hog cooler to about the same, which was really too fast work for pork, and the engineer cut out coils one after the other until he had only half of them working. He was about the most tickled man in town. So were the owners the next morning.

The rest of the coolers and freezers were similarly provided and made it possible to carry the load most of the time with the 40 and 75 ton machines. The suction pressure had jumped from zero to 18 lb.; it would have been considerably higher, but it had to be kept there to keep the sharp freezer at about 10 deg. We had to run at a lower pressure at times to keep the temperature in this cooler to 10 deg. or lower. The superintendent wanted it kept at zero or lower, but when shown how much coal it would cost he agreed to let it go if I would promise to improve conditions later on. The net result was that a large portion of the coils in the chill rooms and storage coolers were out of service part of the time and this did not tend to the most economical operation.

After figuring on the problems for some time I finally suggested installing an additional suction line to connect to the freezers with a cross-connection to the wholesale market cooler and the two storage coolers, as shown in Fig. 2, which was done. We left the 40 ton machine on the three freezers and cut the suction pressure to about 10 lb. At this suction pressure it was possible to keep the sharp freezer at zero to 5 deg. below, while the others were easily carried at 15 to 20 deg. The machine handled the load nicely at a speed of about 55 r.p.m., leaving plenty capacity to spare for hot weather.

On the rest of the system we were able to handle the load the greater part of the time with 28 to 30 lb. suction pressure, as the temperature in the storage coolers and wholesale markets were generally held at 33 to 36 deg. The 75-ton machine carried the load at a speed of 55 to 60 r.p.m. In case it was desired to pull down any one of the storage coolers or the wholesale market in a hurry it was necessary only to switch it over to the low-pressure system.

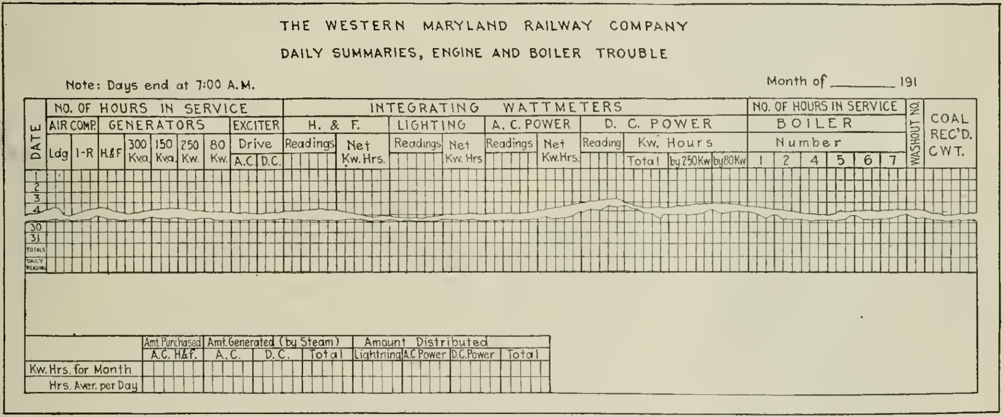
This proved particularly advantageous in case there was a heavy load in the chill rooms at night. The wholesale market, and sometimes one of the storage coolers, was then switched over to the low pressure system and just enough coils used to slowly bring down the temperature. The speed of the other machine would then be increased to maximum. Soon the rest of the rooms would also be cool and from then on it was necessary only to run the machines at normal speed to hold the temperatures. Bringing the temperatures down during the first part of the night's run is the packing house engineer's hardest job, but by this arrangement he can do so without difficulty.

When I first came on the job the condenser pressure was somewhere around 200 lb. By purging the pressure came down to 135 lb. It was now possible to leave the 125-ton machine out of service until very warm weather. So we gave it a thorough overhauling. During the hot weather it was possible to carry a greatly increased load with the 75-ton machine running on the low pressure system and carrying the wholesale market all the time and the 125-ton machine carrying the high pressure part of the system, both machines running not over 60 r.p.m.

When the machines were all gone over we tackled the condenser and cut out one stand at a time, disconnected it at both ends and gave it a thorough blowing out, first with steam and then with air and removed all the scale on the outside of the pipes. When this job was finished we had about three barrels of oil and dirt. In addition to the work on the refrigerating system I suggested a hot water tank in which nearly all the hot water used in the plant was heated by exhaust steam and in addition we arranged for the use of exhaust steam in a number of other places around the plant. When we got through the coal consumption had been cut nearly in half. At any rate where they had before pushed three boilers to the limit they were now able to hold the pressure easily at any time with two boilers.

Boiler- and Engine-Room Record Sheets

BY P. R. DUFFEY



THE WESTERN MARYLAND RAILWAY COMPANY

DAILY SUMMARIES, ENGINE AND BOILER TROUBLE

Note: Days end at 7:00 A.M.

Month of ________ 191

DATE	NO. OF HOURS IN SERVICE									INTEGRATING WATTMETERS										NO. OF HOURS IN SERVICE						WASHOUT NO.	COAL REC'D. CWT.
	AIR COMP.		GENERATORS					EXCITER		H. & F.		LIGHTING		A. C. POWER		D. C. POWER				BOILER							
								Drive									Kw. Hours			Number							
	Ldg	1-R	H.&F	300 Kva.	150 Kva.	250 Kw.	80 Kw.	A.C.	D.C.	Readings	Net Kw. Hrs.	Readings	Net Kw. Hrs	Readings	Net Kw. Hrs.	Reading	Total	by 250 Kw	by 80 Kw	1	2	4	5	6	7		
1																											
2																											
3																											
4																											
30																											
31																											
TOTALS																											
DAILY READING																											

	Amt. Purchased	Amt. Generated (by Steam)			Amount Distributed			
	A.C. H&f.	A.C.	D.C.	Total	Lightning	A.C Power	D.C. Power	Total
Kw. Hrs. for Month								
Hrs. Aver. per Day								

FIG. 1. DAILY LOG OF POWER PLANT, BOTH STEAM AND ELECTRICAL

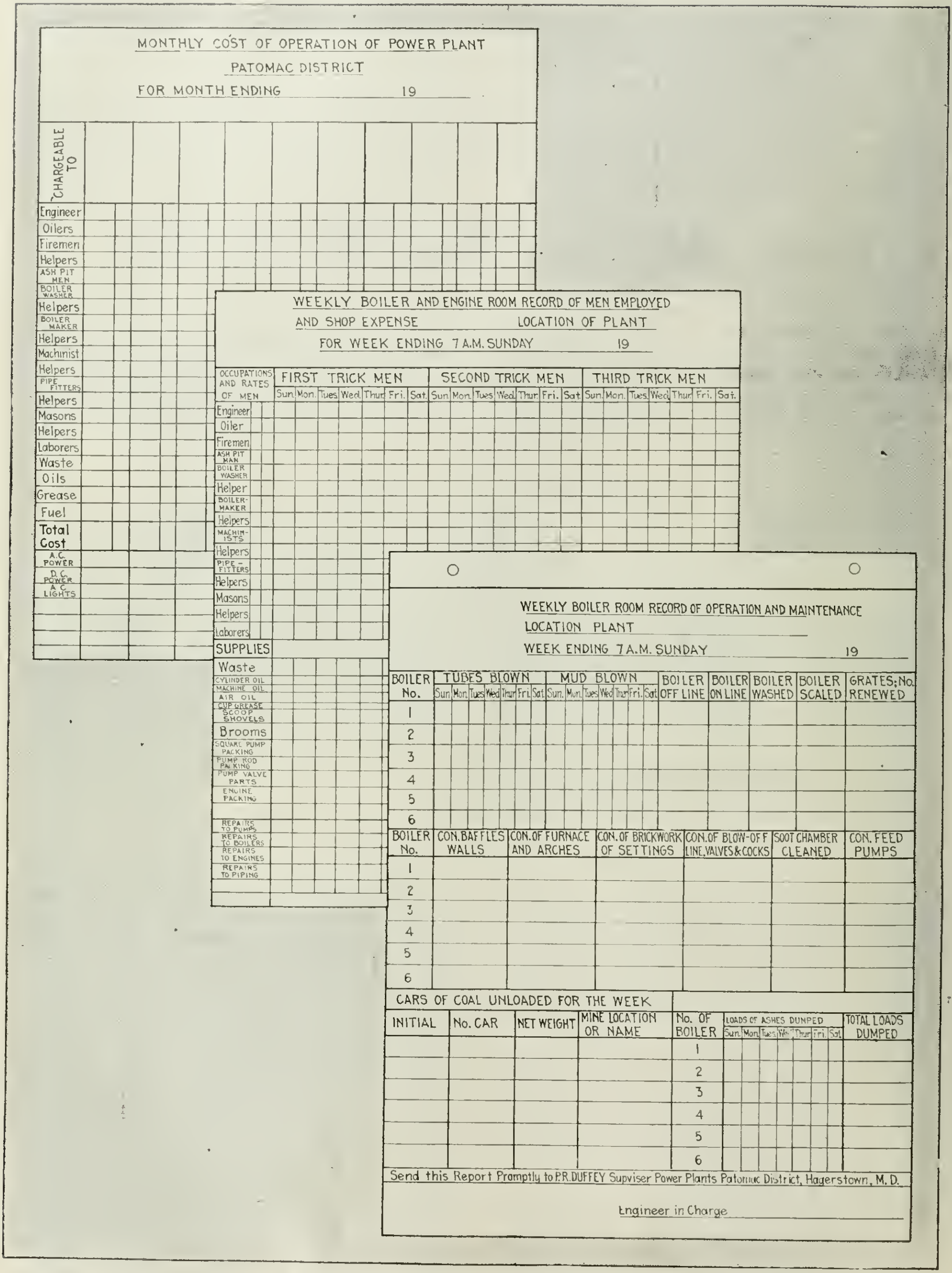
MOST engineers are interested in power-plant record sheets, and the accompanying illustrations are reproductions of some that have proved their worth. The last sheet in Fig. 2, was made up to cover the needs of a weekly boiler-room record from several plants, located in a district covering a radius of 150 miles from headquarters, and reporting to the main organization. Hence a standard form was necessary to cover the general conditions of all plants, and a study of the record will show that this is in evidence. The center sheet shown was made up to cover the needs of a weekly check on operating expenses at each plant, and of the supplies issued.

The monthly cost sheet, Fig. 2, was made up to compile the monthly costs of the various plants and the information obtained from the No. 1 and No. 2 records is used for this purpose. The total kilowatts of power generated is obtained from the record sheet, Fig. 1, and this sheet is used only at plants where electric power is generated or a more elaborate statement than record No. 1 is desired.

The information obtained from these records is giving very satisfactory results and is accurate when the parties in charge give the necessary attention to the work required in making out the record. The recording charts shown in Fig. 3 are from hand-fired plants. One chart is an average sample from a hand-fired plant. The boilers are of the water-tube type, and the grates used are of the locomotive shaking type with the dumps located at the bridge-wall and at the deadplate. This type of grate has large air space between the grates and is well adapted to burning the grades of run-of-mine soft coal used in the locality where this plant is situated. The outer line on the first chart shows the steam pressure and an inner line records the air pressure, which will show at a glance how the two pressures run. This is necessary in the plant where the recorder is located, as operation depends as much on good air pressure as on steam pressure.

The firing method used at the plant referred to is done alternately by hand, and as the load is very irregular, it is hard to maintain an average CO_2 of over 10 per cent. for the 24 hours. An average sample is collected in an automatic gas-collecting tank, and an analysis is made once in 12 hours. At times when the load is reasonably heavy for a long period, a percentage of 12 CO_2 has been obtained on a 4-hr. run. The firemen have been instructed in the use of the draft gage, and with a frequent check on operation coal consumption is kept to the minimum, yet at best there is waste which under present conditions cannot be overcome. The solution would be a stoker installation.

The top right-hand chart shows the temperature of the feed water entering the boiler and also that of



MONTHLY COST OF OPERATION OF POWER PLANT
PATOMAC DISTRICT
FOR MONTH ENDING 19

CHARGEABLE TO									
Engineer									
Oilers									
Firemen									
Helpers									
ASH PIT MEN									
BOILER WASHER									
Helpers									
BOILER MAKER									
Helpers									
Machinist									
Helpers									
PIPE FITTERS									
Helpers									
Masons									
Helpers									
Laborers									
Waste									
Oils									
Grease									
Fuel									
Total Cost									
A.C. POWER									
D.C. POWER									
A.C. LIGHTS									

WEEKLY BOILER AND ENGINE ROOM RECORD OF MEN EMPLOYED
AND SHOP EXPENSE LOCATION OF PLANT
FOR WEEK ENDING 7 A.M. SUNDAY 19

OCCUPATIONS AND RATES OF MEN			FIRST TRICK MEN							SECOND TRICK MEN							THIRD TRICK MEN						
			Sun.	Mon.	Tues	Wed.	Thur.	Fri.	Sat.	Sun.	Mon.	Tues	Wed.	Thur.	Fri.	Sat.	Sun.	Mon.	Tues	Wed.	Thur.	Fri.	Sat.
Engineer																							
Oiler																							
Firemen																							
ASH PIT MAN																							
BOILER WASHER																							
Helper																							
BOILER-MAKER																							
Helpers																							
MACHIN-ISTS																							
Helpers																							
PIPE-FITTERS																							
Helpers																							
Masons																							
Helpers																							
Laborers																							

SUPPLIES					
Waste					
CYLINDER OIL					
MACHINE OIL					
AIR OIL					
CUP GREASE					
SCOOP SHOVELS					
Brooms					
SQUARE PUMP PACKING					
PUMP ROD PACKING					
PUMP VALVE PARTS					
ENGINE PACKING					
REPAIRS TO PUMPS					
REPAIRS TO BOILERS					
REPAIRS TO ENGINES					
REPAIRS TO PIPING					

○ ○

WEEKLY BOILER ROOM RECORD OF OPERATION AND MAINTENANCE
LOCATION PLANT
WEEK ENDING 7 A.M. SUNDAY 19

BOILER No.	TUBES BLOWN							MUD BLOWN							BOILER OFF LINE	BOILER ON LINE	BOILER WASHED	BOILER SCALED	GRATES; No. RENEWED
	Sun	Mon	Tues	Wed	Thur	Fri	Sat	Sun.	Mon.	Tues	Wed	Thur	Fri.	Sat					
1																			
2																			
3																			
4																			
5																			
6																			

BOILER No.	CON. BAFFLES WALLS	CON. OF FURNACE AND ARCHES	CON. OF BRICKWORK OF SETTINGS	CON. OF BLOW-OFF LINE, VALVES & COCKS	SOOT CHAMBER CLEANED	CON. FEED PUMPS
1						
2						
3						
4						
5						
6						

CARS OF COAL UNLOADED FOR THE WEEK

INITIAL	No. CAR	NET WEIGHT	MINE LOCATION OR NAME	No. OF BOILER	LOADS OF ASHES DUMPED							TOTAL LOADS DUMPED
					Sun.	Mon.	Tues	Wed	Thur	Fri.	Sat	
				1								
				2								
				3								
				4								
				5								
				6								

Send this Report Promptly to P.R. DUFFEY Supviser Power Plants Patomac District, Hagerstown, M. D.

Engineer in Charge

FIG. 2. THREE RECORD SHEETS THAT HAVE PROVED THEIR WORTH

the feed-water heater. A constant line indicates the temperature of the water entering the boilers from the heater. A variable line indicates the temperature of the water entering the heater. The many rises of this line indicate the number of times the water-inlet valve closed during the day's run, showing further that the heater is not being worked to full capacity at any time, otherwise the inlet valve would remain open practically the entire period. Further, it will be seen that the temperature recorded when the valve is closed is several degrees above that of the water entering the boilers. This is due to the fact that the exhaust steam coming in contact with a diminished water supply heats very rapidly the small supply of water entering the heater through the bypass on the inlet line. This check has been discontinued, and the thermometer bulb is now placed in the steam line to record the temperature of the steam being delivered.

The remaining three charts are taken from the operation of a hand-fired plant having a constant load and using river anthracite culm as fuel. One chart shows a record of steam pressure, another the record of feed-water temperature, and the center one shows a record of the air pressure.

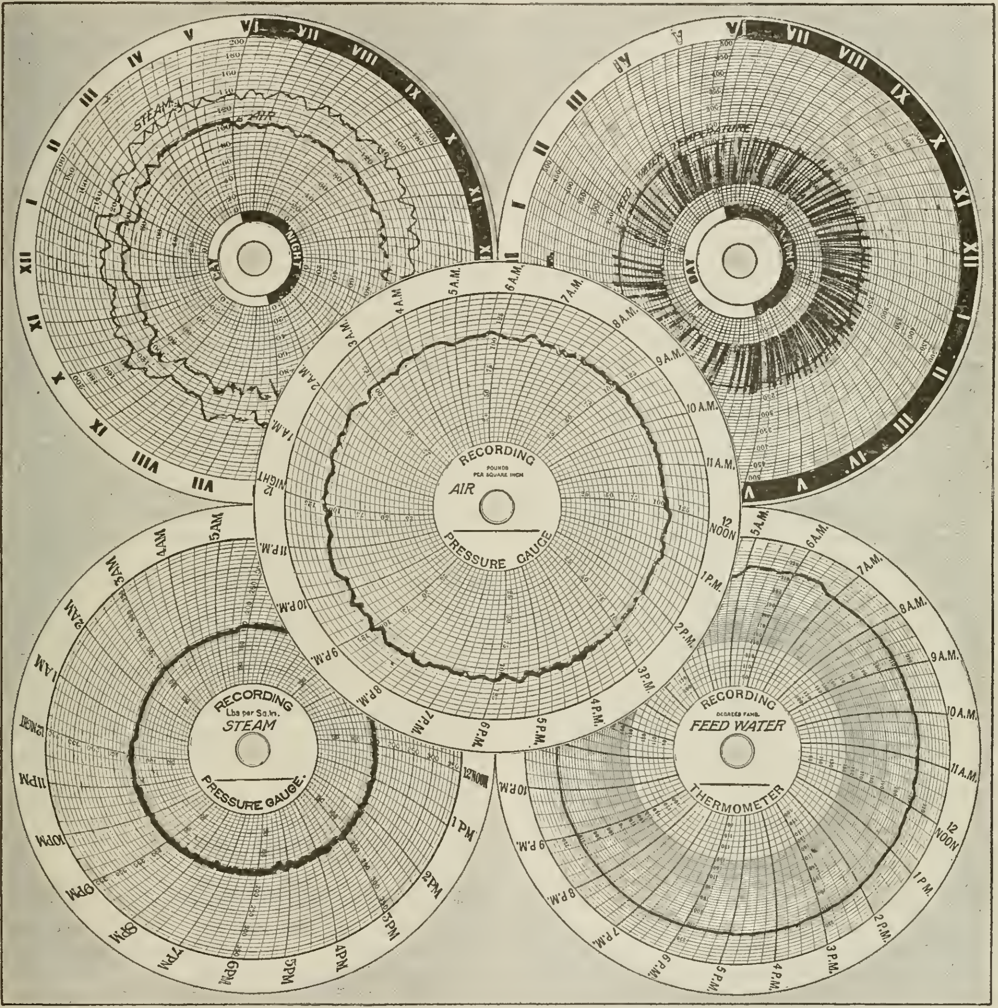


FIG. 3. CHARTS FROM RECORDING INSTRUMENTS IN A HAND-FIRED PLANT

A system of shaking and dumping grates and forced draft is employed to burn this fuel, as well as combustion arches in the furnace for igniting the fuel. This fuel runs very high in moisture and ash, and the temperature required for ignition is high. Where the cost of such fuel is low and transportation charges low, it is economical to burn, otherwise the gains thus obtained would be offset by a loss.

Experiments on Stack Performance

BY JULIAN C. SMALLWOOD

The purpose of the investigation to be described here is to compare experimentally determined temperatures, velocities and pressures in a stack with the values assumed and the results calculated in design. From such a comparison, with complete data, can be deduced values of friction losses in stacks, concerning which there is practically little known.

HEIGHT and area are the two most important quantities to be found in chimney design. To calculate the height necessary for a required draft, one must make certain assumptions, the most inexact being that of stack-gas temperature. Given a knowledge of this variable quantity, one could figure the necessary stack height with precision, provided friction losses are kept low. It is probable that these losses follow the general laws governing fluids and vary with the square of the velocity. Consequently, if stack-gas velocity is low friction loss is negligible, and the actual draft closely approximates that calculated from the theoretical formula, provided the correct stack-gas temperature is inserted. To keep the velocity as low as this, however, means that the cross-sectional area of the stack must be prohibitively large. For economy in construction this area should be as small as may be without increasing the velocity and resulting friction losses to such an extent as to diminish greatly the available draft. The usual method of proportioning stacks is to calculate the height from an assumed temperature at the base, which is probably always much higher than the average temperature of the whole column, and to make a generous allowance for this inexactitude and to cover friction losses. The area is then obtained by an empirical formula, such as Kent's, depending upon examples in practice. It is reasonably certain, however, that in ordinary practice the stack carries much more air than passes through the furnace, because of infiltration through idle boilers, clean-out doors, leaky joints between metal and brick, and other defects in metal and brickwork. The formula thus yields larger stack areas than would be necessary if such imperfections were eliminated. At all events the whole method is unscientific and inexact.

An admirable advance from this rule-of-thumb procedure has been suggested by A. L. Menzin (Vol. 37, "Transactions American Society Mechanical Engineers") in a rational method of stack design. The advance, however, is largely mathematical, as he presents no method of arriving at the true density of the stack gases (that is, of estimating their temperature), uses values of friction coefficient based on old and limited experiments, and does not state how he has selected his table of "economical gas velocities."

The questions, then, first to be answered before an exact method of stack design can be put into effect are:

What are the average temperatures of gases in stacks of different types, corresponding to initial temperatures at their bases?

How does the loss of draft pressure, due to friction, vary with stack-gas velocity?

It should be stated at the outset that these two questions were not satisfactorily answered in the present investigation for the following reasons: First, an answer to the question regarding temperature, to be of general applicability, should be based on data from numerous stacks under all the variable conditions of operation, whereas only one stack was available and that only during the cold months. Second, because the equipment was not, and probably will not be for an indefinite time, operated at anywhere near its rated capacity, the stack-gas velocity was very low, making the friction losses too small to be accurately measured. On the other hand, certain methods of measurement were decided upon and certain others eliminated as inappropriate, a good deal of preliminary work was done, and some significant measurements were made. Therefore, as a guidance to other investigators of the same subject and as a matter of interest to others, it has been thought worth while to describe the present work, incomplete as it may be.

The experiments were made on the stack at Johns Hopkins University, which stack takes care of four boilers rated at 1000 hp. The design is a Custodis, hexagonal, brick. It is 8 ft. 9 in. across the inside section at the bottom, and tapers to 7 ft. inside at the top, and is about 150 ft. high from the ground. The thickness of the walls is 27.5 in. at the base, 17 in. just above the firebrick, and 9 in. at the top. The firebrick lining, with 2 in. air space extends 50 ft. from the plane of the bottom of the breeching, which plane is taken as a datum. The breeching is 8 ft. high by 5 ft. wide.

There are two landings or platforms encircling the stack at distances of 33 and 55 ft. above the datum plane. At each landing there are eight 2-in. capped pipe openings for the insertion of pitot tubes, draft-gage connections, thermocouples, etc. These openings are on horizontal median lines at right angles.

Underneath the stack proper is built an instrument room in which the measuring instruments were set up. Draft gage and thermocouple connections were led here from the two landings, the top of the stack, and from the breeching.

Fig. 1 is a diagrammatic arrangement of the equipment.

It is perhaps best, now, to relate the considerations influencing the selection of instruments.

DRAFT PRESSURE AND TEMPERATURE MEASUREMENTS

For measuring pressures the inclined U-tube was used, of the form adopted by William Rowse in his experiments upon pitot tubes (Vol. 35, "Transactions A. S. M. E."). This draft gage is 5 ft. long, of large-bore tubing, and can be set at any desired small angle with the horizontal so as to make a large motion of the liquid level. The liquid was gasoline or kerosene. Two gages were used having been previously calibrated against a micrometer point gage precise to 0.001 in. It was found by repeated calibrations that the U-tubes were accurate and could be read to 0.002 in. This was satisfactory in so far as draft pressures were concerned, but not so in connection with the pitot tubes.

The familiar Ellison draft gage can be read to 0.005 in., and is more convenient to read. Where this is sufficient precision, this gage is therefore preferable.

The original idea of measuring the temperature within the stack was to use an electric resistance thermometer, fitting as closely as possible the entire stack cross-section, and to arrange this thermometer to be pulled from bottom to top. This would give an average temperature reading at any desired plane, but had the disadvantage that it made impossible simultaneous readings. Such a thermometer was actually constructed of fine nickel wire and carefully calibrated. It was found, however, that the stack gases changed the electric resistance of the nickel, this effect probably being due to a chemical action between carbon monoxide and nickel. Various alloys and materials made into wire were then tested with the purpose of finding one that would not be attacked and changed in electrical resistance by the stack gases. All showed an increase of resistance when allowed to remain in the stack from one to five days. It is possible that a solution of this problem lies in a sheathed resistance.

Failing with this type of thermometer, thermocouples were resorted to. The materials were copper and copper-constantin. After weeks of exposure to the hot gases they were found to be as accurate as when first introduced into the stack. As it was desired to insert them as far as the middle of the stack in a horizontal position (that is, about five feet from the outside wall), they were incased for stiffness, in light $\frac{3}{4}$-in. brass tubes 6 ft. long. The couple wires were insulated from it and each other by inclosing each in a one-length glass tube. Thus the brass tube inclosed the two glass tubes side by side, and the hot junction was allowed to project about an inch from the brass casing.

By means of these instruments and a four-point switch quick definite readings were taken with a millivoltmeter, of temperatures at the top, top landing, bottom landing, and in breeching, in less than a minute. (See Fig. 1 for these locations.) By introducing two couples at opposite openings on one landing, readings could be made across the stack and temperatures at various points compared with that at the center.

After calibration the couples were found accurate to within 5 deg. F.

The main objection to this arrangement (as shown at Fig. 1) was that although the readings at all four points could be taken practically simultaneously (that is, within one minute) they applied only to one point at each plane. Later readings showed that the temperature across the stack at one plane varied considerably, undoubtedly because of stratification of the gases. An improvement on the arrangement would be to have at least four couples at each plane, so arranged as to yield an average temperature. Recording apparatus would be suitable, both to get continuous records and to reduce the number of observers.

Velocity Measurement

Pitot tubes were tried for velocity measurement, the differential gages being of the form used for draft-pressure measurement, previously described. But, because of the low velocities prevailing, the velocity head was too small to be read with these gages.

Stack-gas velocities are generally between 5 and 40 ft. per sec., corresponding with velocity heads of 0.004 and 0.12 in. of water, respectively. During the experiments under discussion, values near the lower limit were realized. As the gages could not be read closer than 0.002 in., it was impossible to measure the velocity head with precison or to study its variation. Even with the higher velocities this would not be close enough. It was therefore attempted to make a more sensitive differential gage but without success, although numerous expedients were tried. It is very questionable, at all events, that the pitot tube is reliable at these low velocity heads.

Other instruments were considered and tried, such as the hot-wire anemometer and impact vanes. The latter, at first, promised a solution of the problem. A round vane on the end of a lever was placed in a current of air with its plane perpendicular to the flow. It was planned to measure the impact on this vane by weighing, a knowledge of which would make possible the calculation of velocity. It developed, however, that a low-velocity air current impinging against such a vane is attended by eddies which cause a pulsation and a great variation on the weighing apparatus and prevent a close reading of the average impact.

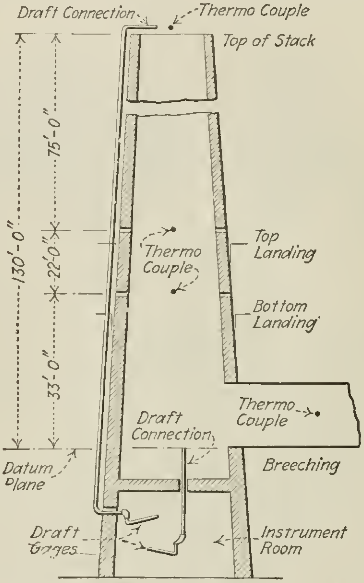


FIG. 1. DIAGRAM OF STACK AND EQUIPMENT

The problem of measuring small velocities in a stack is still open for solution. It is highly desirable to measure not only average, but local velocities at any point or plane. There is much evidence to show that stack-gas flow is very irregular; in our present ignorance of the controlling laws it might even be termed capricious. There are many eddies, local accelerations, and even down-drafts. For a complete analysis of what takes place in a chimney it is necessary to measure these in extent and direction, and until some method of doing so is perfected, chimney design and construction will remain imperfect.

In the present investigation stack-gas analyses were occasionally made with the purpose of finding the amount of air leakage beyond the boiler.

Variation of temperature at one cross-section was found by comparing readings from two couples at one landing, one located with its hot junction at the center of the stack and the other at successive positions one foot apart from one wall to the opposite. The two couples checked at the center, but the traversing couple showed on some days higher temperatures on the east side than on the west, and on other days just the reverse. A higher temperature at the center than on the sides was in no case realized. The maximum variation from center to side was ten degrees. It was concluded that the observed variation was due to the stratification of the stream of chimney gases.

Similar tests were made by traversing a vertical section of the breeching. The greatest variation was 20 deg., but in most cases it was from 5 to 10 deg. The variation was irregular, sometimes being hotter at the bottom and sometimes at the top, depending largely upon damper opening.

The most important readings were those giving the temperature gradient from top to bottom of stack. For each series of such readings draft pressures were also noted at each of the points indicated on Fig. 1. The accompanying table presents some of the results, drafts at the landings being omitted. The quantities in each series in this table are averages of at least three sets of observations under practically the same conditions.

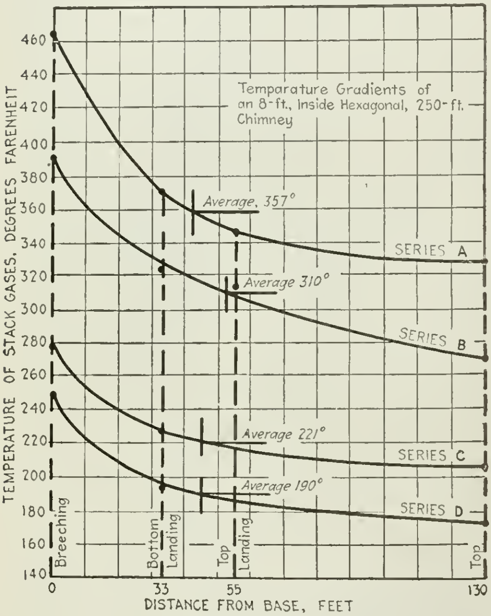


FIG. 2. TEMPERATURE GRADIENTS

The draft pressure at the top of the stack is due either to the column of hot gases rising above the stack or to the aspirating effect of the wind. This value subtracted from the draft at the bottom gives the actual draft pressure due to 130 ft. of stack with gases at an average temperature as given under each series. This average is found by plotting the temperatures as shown by Fig. 2 and determining the average height of the curve by planimeter.

The last item given in the table is the ideal draft pressure as obtained by the theoretical formula, without allowing for friction losses. The difference between the ideal and corresponding actual draft, it was expected, would disclose values of the friction losses, but owing to the low velocities and consequent small friction heads, these values could not be measured with precision, and in fact with some of the readings gave slightly negative results.

Analyses of the gases at the base of the stack showed the CO_2 in every case to be less than 5 per cent. as compared with 10 per cent. and over at the last pass of the boilers. It should be explained that the breeching received the uptakes from four 250-hp. boilers and one independently fired superheater. Only two of these boilers were in service and generally not to capacity. The superheater was idle. Consequently, there was ample opportunity for air leakage through these idle units. Every precaution was taken to avoid such leakage, even to the calking of dampers and clean-out doors, but there was a large leakage, particularly through the stokers, as was evidenced by a torch as well as by the gas analysis. Some of the excess air was undoubtedly due to leakage at the joint between breeching and stack, making a steeper temperature gradient between breeching and bottom landing than would be obtained by radiation alone.

RESULT OF AIR DILUTION

The chief result of the air dilution was to make much lower initial stack-gas temperatures than are usually assumed. Series *A* and *D*, in the table and curves, Fig. 2, give the highest and lowest temperatures found. That the gas in the breeching is lower in temperature than the boiler steam is due, of course, to the cooling effect of the air leaking through the idle units. In this case the lowered stack-gas temperatures and consequently reduced draft did not affect the facility of boiler operation, since the plant is supplied with forced draft, a balanced system being in use. One cannot but be impressed, however, by the very considerable result of idle boilers to lessen the effectiveness of a stack. Even with the tightest sort of setting it is practically impossible to eliminate air leakage through an idle boiler.

An inspection of Fig. 2 is interesting. It is seen that the greatest fall in temperature of the gases in their ascent of the stack is 155 deg. and that the lower the average temperature the less the cooling during ascent. An exception to this is seen in the lowest curve, which has five degrees less cooling than *C*, just above it, but this is undoubtedly because the day was colder.

TEMPERATURES AND DRAFT PRESSURES

Series	A	B	C	D
Temperatures, deg. F.:				
Breeching	464	390	277	249
Bottom landing	370	324	226	194
Top landing	346	313	...	..
Top	328	270	206	173
Average from curve	357	310	221	190
Outside air	40	38	43	24
Pressures, inches:				
Barometer	30.06	30.00	29.63	30.27
Draft, bottom	0.772	0.6[illegible]7	0.518	0.555
Draft, top	0.038	0.032	0.048	0.05
Draft, for 130 ft.	0.734	0.665	0.470	0.500
Calculated draft for 130 ft	0.752	0.685	0.492	0.504

It seems difficult to believe that in the 15 to 25 sec. duration of passage in the stack the gases should cool to such an extent, especially when the thickness of the wall and the size of the inside cross-section are considered. Yet these results are assuredly valid. The only similar test results extant, to the writer's knowledge, are the ones made under the supervision of Prof. E. F. Miller at the Massachusetts Institute of Technology. A brief account of this work, with temperature gradients, was published in *Power*, Mar. 31, 1914, p. 461. It appears from their curves that the fall in temperature of gases in an 18-ft. internal diameter, 3 ft. thick at the base, was 80 deg. after a travel of 130 ft., the initial temperature being 480 deg. This compares favorably with series *A* in the present article. The 18-ft. stack was 250 ft. in height, and the gases cooled an additional 20 deg. from the 130-ft. level to the top, making the upper half comparatively ineffective, since the average temperature there was thus roughly 390 deg. The article referred to also shows that a 3-ft. square stack 102 ft. high, almost completely inclosed in a building at 70 deg., allowed a temperature fall of 175 deg., the initial being 440. From these figures and the data of the accompanying table it appears that the reduction of temperature through radiation from the stack is markedly less with the larger cross-sections. It is hardly needful to mention that this is in accordance with the fundamental principles of radiation.

It follows from the experimental results discussed that it is highly irrational to assume that the average temperature of the hot column is that at the base, as is done in design and in the formulation of tables of chimney drafts. A logical inference, too, is that the cooling may become so pronounced with high chimneys that their upper parts may be a hindrance instead of a help. With high stack-gas velocities, the friction losses of the upper part might easily exceed the theoretical draft pressure produced by this cool upper portion. Finally, it seems certain that, except in the most refined design and operation such as prevail at some large central stations, leakage of air lessens both the draft pressure and the boiler horsepower which can be accommodated, and if this could be eliminated, both height and area could be reduced without reducing the draft or capacity.

Acknowledgment must be made to Prof. Carl C. Thomas, who inspired the work of this investigation at Johns Hopkins University and to M. X. Wilberding, who began the experiments and with the writer carried them along.

Dismantling a Large Motor

By H. Wilson

If there is one thing that the electrical repairman is more familiar with than anything else it is hurry up jobs. The importance of electric motors in most industries today makes it very essential that they be kept in operation; therefore if one fails it means hurry up and get it back into service or install a spare machine. Recently I had the job of assisting in the repair of a large 500-volt three-phase 25-cycle induction motor, which was directly connected to a direct-current generator. It was a three-bearing equipment, the motor's rotor and generator's armatures being keyed on the same shaft. The middle-bearing housing was mounted on the motor and was split horizontally as in Fig. 1. In taking the machine apart to get at the stator winding in the motor, the inner bearing was removed, the base bolts and dowels taken out and the stator pushed out so that the end of the rotor shaft was only one-quarter way in the outer bearing, then a jack was set under the shaft as close as possible to the rotor and the weight of the latter taken on it, a wooden block being placed between the jack and the shaft to prevent injury to the latter. Then an extension to the bedplate was built with timbers, and after this the outer bearing was removed and the stator pushed out on the beams so that the winding could be repaired.

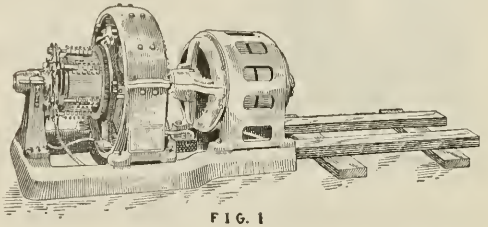


FIG. 1

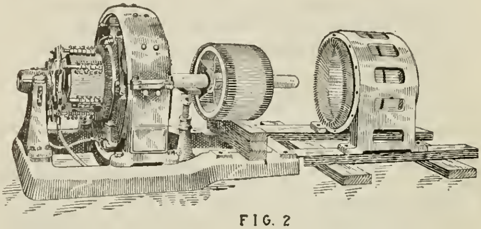


FIG. 2

FIGS. 1 AND 2. MOTOR ASSEMBLED AND STATOR REMOVED FROM BASE

The bottom coils had become soaked with oil, rotting the insulation, and no doubt the vibration of the coils themselves did the rest. The little old juice jumped to ground and put some twenty coils on the casualty list. As luck would have it we had sufficient spare coils in stock to do the job. With two men working, one on each end of the winding, the damaged coils were quickly removed with pinch bars and coil lifters. The tools used to lift the coils were like those shown in Fig. 3. No. 2 was used to raise the coils a little at one end, then No. 1; the wedge-shaped one was pushed under the coils in the slots and used to pry them up. No. 3 has projecting shoulders which rest on top of the slot and is used as a powerful lever for lifting tight coils. They are all made of steel in sizes to suit small or large machines. The edges, of course, are nicely rounded in order to prevent damage to the coils. When the machine was again ready for service it was easily assembled by reversing the dismantling operations.

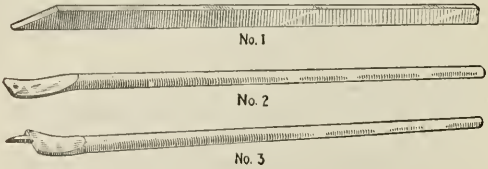
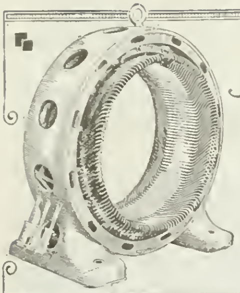
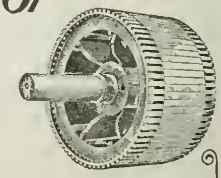


FIG. 3. TOOLS FOR REMOVING COILS

The development of the great waterfalls of Iguazu in the northern part of Argentina, will be undertaken by the Argentine government, which has the matter of turning the energy of the falls to commercial use under consideration. These falls, located in an almost inaccessible district, are visited only by tourists, many of whom claim that they are larger than Niagara.



How an Induction Motor Operates as an Induction Generator



By F. A. Annett

Describes how the current is set up in the rotor bars of an induction motor, and how this current acts upon the stator flux to produce rotation. Also shows how an induction motor can be made to operate as a generator.

IN THE article, "The Revolving Magnetic Field of Alternating-Current Motors," in *Power*, Sept. 2, it was shown how a revolving magnetic field could be produced by an arrangement of windings like that in Fig. 1, connected to a two-phase circuit. In the discussion in that article the magnetic field was made to revolve in a clockwise direction. Starting with this assumption in this article, consider the action of the field on the rotor, to produce rotation. Assume the rotor to be at standstill, as at the instant of starting, and with the magnetic field revolving in a clockwise direction. The lines of force will be cut in a counterclockwise direction. This condition is the same as though the magnetic field was stationary and the rotor was revolved in a counterclockwise direction. This will be made clear by referring to Figs. 2 and 3. In Fig. 2 assume conductor *A* to be stationary and the magnetic field moved horizontally in a right-hand direction, as indicated by arrow *B*. Then the magnetic field would be cut by *A* from right to left. This would be the same as if the magnetic field were held stationary and the conductor moved horizontally to the left, as shown by arrow *B*, Fig. 3. When the conductors are cutting the lines of force in a counterclockwise direction, Fig. 1, those under the N poles will have a voltage induced in them that will cause a current to flow toward the reader, as indicated by the dots on the end of the conductor. The conductors under the S poles will have voltage generated in them that will cause current to flow down through the plane of the paper, as indicated by the crosses on the end of the conductors. Considering the action of the current in the rotor conductors on the magnetic field from the polepieces will show that it produces a turning effort in a clockwise direction; in other words the rotor in an induction motor turns in the same direction as the magnetic field revolves.

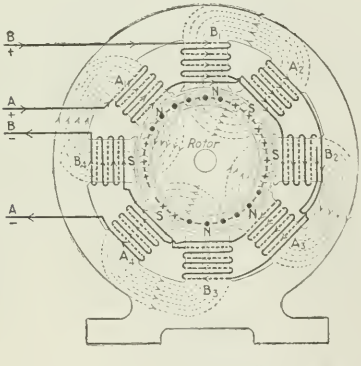


FIG. 1. FOUR-POLE INDUCTION MOTOR

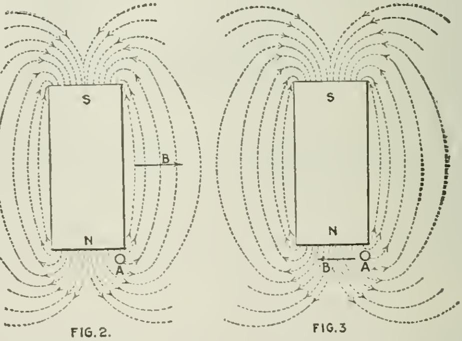


FIG. 2.

FIG. 3

FIGS. 2 AND 3. CONDUCTOR IN MAGNETIC FIELD

At the instant of starting the rotor is at a standstill and the magnetic field is revolving by the rotor conductor at a speed, as was shown in the previous article, which equals 120 times the frequency divided by the number of poles, or, for a four-pole machine on a 60-cycle circuit, equals 120 × 60 ÷ 4 = 1800 revolutions per minute. This gives the maximum rate of cutting the lines of force, and consequently generates a maximum voltage in the rotor conductors of a frequency equal to the voltage applied to the stator.

Why the frequency of the rotor current will be the same as that of the stator current will be understood when it is remembered that in the previous discussion the polarity of the field coils changed with each alternation; therefore if the polarity of the field coils changed with each alternation, the voltage generated in the conductors under the polepieces will change with each alternation.

Assume that the magnetic field is rotating at 1800 r.p.m. and that power is applied to the rotor and caused to also run at 1800 r.p.m. in the same direction as the magnetic field. Under such a condition the motor conductors and the magnetic field would be running at the same speed, therefore the former would not be cutting any of the lines of force, consequently the voltage in the conductors would be zero and no current would flow in them. From the foregoing it is evident that when the rotor of an induction motor is at a standstill the voltage and frequency are at a maximum, but that as the rotor comes up to speed, the voltage and frequency of the rotor current decrease until when the rotor is running at the same speed as the magnetic field, the voltage and frequency become zero. Since no current flows in the rotor conductors when they are moving at the same speed as the magnetic field of the stator, no torque, turning effort will be produced. In the foregoing is found the explanation why the rotor of an induction motor must run slower than the stator's magnetic field. The rotor runs just enough slower than the field to set up sufficient current in the rotor bar to develop the torque necessary to drive the load. If there is no load on the motor, then the rotor runs at practically the same speed as the magnetic field, but as the load is increased the speed decreases until at full load the difference in speed will amount to from about 3 per cent. for large, efficient machines to about 10 per cent. for small machines. The difference between the speed of the magnetic field and the rotor is called the slip and is usually expressed as a percentage of the speed of the magnetic field, which is the synchronous, or theoretical, speed. Where S_m represents the speed of the stator's magnetic field and S the speed of the rotor,

$$\text{per cent. slip} = \frac{S_m - S}{S_m} \times 100.$$

Assume that a four-pole 60-cycle induction motor runs 1675 r.p.m. at full load, find the per cent. of slip? In the foregoing it was found that the theoretical speed of a four-pole 60-cycle motor is 1800 r.p.m., then the

$$\text{per cent. slip} = \frac{1800 - 1675}{1800} \times 100 = 7;$$ that is, the rotor is running about 7 per cent. slower than the magnetic field of the motor. The speed marked on the nameplate on induction motors is usually the full-load speed, consequently somewhat less than the theoretical speed figured from the number of poles and the frequency.

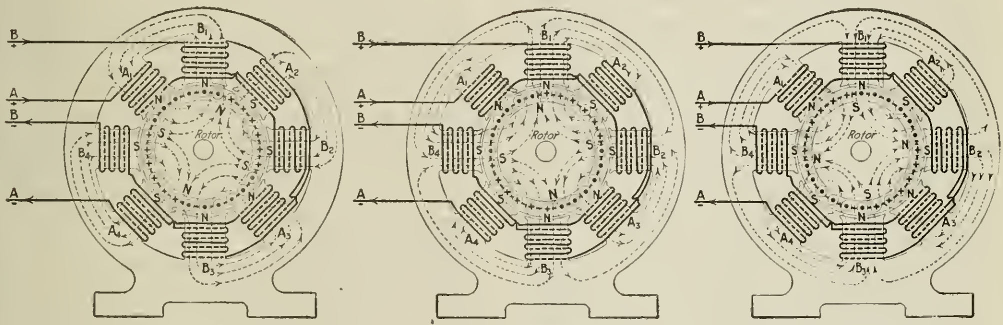


FIG. 4 FIG. 5 FIG. 6

FIGS. 4 TO 6. SCHEMATIC DIAGRAMS SHOWING MAGNETIC FIELD DUE TO ROTOR CURRENT IN AN INDUCTION MOTOR

The current taken from the line by the stator of an induction motor is not only limited by the ohmic resistance of the stator winding, which is always comparatively small, but also by the counter-voltage generated in the winding, the latter being almost equal to the applied volts, there being only sufficient difference to allow the current to flow necessary to carry the load on the motor. The counter-voltage induced in the stator winding is similar to the counter-electromotive force generated in the armature of a direct-current motor. In the latter case this back pressure is produced by the armature conductors cutting the lines of force from the polepieces, where in the former it is induced in the stator winding while the alternating magnetic field changes in value about the conductors. At no load the current taken from the line is that necessary to magnetize the stator and rotor core and supply the losses in the motor.

If we consider the action of the current in the rotor bars alone, as in Fig. 4, it will be found to produce a magnetic field as shown. This is the resultant field from the clockwise field set up about the conductors carrying current away from the reader and the counter-clockwise field set up about the conductors carrying current toward the reader. By comparing Figs. 1 and 4 it is seen that the center of the magnetic field of the rotor is located between the poles of the stator. This is the condition to be desired, since the rotor poles exert a minimum demagnetizing effect on the stator poles, and also all the rotor conductors under each pole are carrying current in the same direction, consequently producing a given torque with a minimum current. However, owing to the effect of inductance in the rotor the current lags behind the voltage generated in the rotor conductors, and instead of the current being distributed as indicated in Fig. 4, the actual conditions approach those of Fig. 5. Here it is seen that, owing to the rotor current lagging behind the voltage, the rotor's N and S poles come considerably back under the stator's N and S poles respectively. Consequently, the rotor poles have a demagnetizing effect on the stator poles. In fact the rotor current of an induction motor has the same effect upon the stator as the secondary winding of a transformer has on the primary.

Assume that power is applied to the rotor, Fig. 1, and it is caused to run faster than the magnetic field. Under such conditions the rotor conductors will be cutting the stator field in an opposite direction to that shown in Fig. 1, consequently the voltage and current set up in the rotor conductors will be opposite to that in Figs. 1, 4 and 5. The conditions with the rotor running faster than the magnetic field are shown in Fig. 6. Now if the current set up in the rotor when it is running slower than the magnetic field is a demagnetizing current, the current set up in the rotor when the motor is caused to run faster than the magnetic field is a magnetizing current. This is at once evident from Fig. 6. Here we find that the north poles of the rotor are under the S poles of the stator and the S poles of the rotor under the N poles of the stator. This brings about a condition where the rotor current can supply the necessary magnetic field to generate the counter-voltage in the stator windings. However, when the rotor has increased in speed a small percentage above that of the magnetic field the counter-voltage of the stator will have increased above the applied voltage and the motor will become a generator. Then, instead of the machine taking power from the line to drive it, as a motor, it will require mechanical power applied to the rotor to drive the latter faster than the magnetic field, and the machine becomes what is known as an induction generator.

From the foregoing it is seen that an induction generator is nothing more nor less than an induction motor with some source of motive power applied to its rotor to drive it faster than the stator's magnetic field. An inductor motor used to drive an elevator acts as an induction generator when the car is traveling in the down motion under heavy load; the motor becomes a generator and pumps current back into the system, which causes it to act to prevent the car from racing.

Induction generators have been used to some extent, driven by low-pressure turbines in parallel with reciprocating-engine-driven alternators, the steam turbine being run without a governor and the speed being taken care of by the steam-engine governor. Probably the most notable installation of this kind is that in the Interborough Rapid Transit Company's 59th Street plant in New York City, made a number of years ago. In this plant there are five of these machines, each of 7500-kw. capacity, driven by low-pressure steam turbines operating in parallel with the 7500-kw. steam-engine-driven units. Other cases where induction generators are used are in small water-power plants tied in on a large system. The waterwheels are run without a governor, consequently the machine operates up to its full capacity continuously. Such plants are generally operated without an attendant, except probably an inspection once per day.

The chief advantages of such machines is their sturdy construction and the fact that they require no source of direct-current excitation. On the other hand, the machines are not capable of exciting their own field, consequently must operate in parallel with standard-type alternators. If it were possible to maintain a leading power factor on the system, an induction generator could be operated alone after it had been brought up to speed and connected in on the line. However, this has not been found feasible in general practice.

Relation Between Carbon Dioxide and Rated Capacity

By B. J. Lewis

We are told that the presence of 15 per cent. of carbon dioxide in the flue gases is indicative of complete combustion. In general this is accepted as the amount one should obtain. This will result at times in an increase in the cost of steam generation instead of a saving, owing to the fact that no attention has been paid as to the quantity of steam generated.

The benefits derived from the flue-gas analysis cannot be overestimated when they are conducted properly, and we agree that high CO_2 is indicative of high furnace efficiency when properly applied, but we must also agree that it is not always indicative of high boiler efficiency. There are, of course, exceptions to all rules. In this case it would apply to a boiler and furnace where capacity is sought without regard to efficiency, but where the relation can be worked out I believe it is the proper policy to follow. At the same time the flue-gas analysis is taken, it is not a bad idea to have a record of the escaping gas temperatures, as with this sort of a record it is possible to determine the amount of heat being absorbed by the boiler.

I do not say that high boiler efficiency is impossible with a high percentage of CO_2, but I do say that a relation between the CO_2 percentage and the capacity developed should be determined for each unit or plant; such determinations are made by many well-known plants, and the results have proved satisfactory.

After the CO_2 instrument has been installed, you should not be satisfied when you have gained a high percentage of CO_2, but should learn your relation between the CO_2 percentage and the amount of steam generated, which in turn will give you information as to the proper amount of CO_2 that will deliver the highest boiler, furnace and grate efficiency.

When the differential draft gages are mounted at the furnace and damper and the CO_2 instrument is put into service, I have always found that the relation between CO_2 draft and fuel thickness gives helpful information.

Following is a method for conducting on a boiler a test by operating the boiler at different capacities until the exact relation between the percentage of CO_2 and the capacity is found. It is sometimes necessary to make certain changes in the furnace or method of damper regulation and we have made changes where we could maintain higher CO_2 and at the same time get better boiler efficiency. As fast as the determinations are made, each steam-flow indicator is marked at the horsepower that gives the highest over-all efficiency, and the firemen are instructed to keep it at that point.

We also use CO_2 recorders, steam-flow recorders, recording thermometer and recording draft gage, which puts us in a position to know just what efficiency we are getting.

That the airplane engine is not above ordinary humdrum work is shown by the fact that one has recently been installed in a London factory as a stand-by power unit. It burns gas and the cooling water is circulated through a common cast-iron radiator. It is an eight-cylinder engine and is rated for aërial work at 200 hp., but this rating has been reduced for its present work to 57 hp. The space occupied by the engine is only 8 x 5 ft., and 5 ft. high, and its weight about 800 pounds.

EDITORIALS

Use of Fuel Oil in New York City

IT IS probable that the laws and ordinances relating to the storage and use of fuel oil in New York City will soon be so modified that the steam plants of a number of office and commercial buildings may be equipped with oil storage and burning appliances in time for operation during the coming winter. In many of the large cities of the Western States fuel oil is extensively used for the generation of steam in commercial and manufacturing establishments, but in New York the restrictions of public ordinances and insurance regulations, with respect to storage and use of kerosene and more volatile liquid fuels, has heretofore been construed by the municipal authorities as applicable to all kinds of fuel oils, and the conditions imposed have made the use of liquid fuels in the congested sections of the city all but impossible.

Urged by the coal shortage and increased cost of labor for handling coal and ashes, the owners of many office buildings have insisted that if, in Chicago, San Francisco and other large Western cities, fuel oils can be stored and used with safety, and with fuel oils offered on favorable terms, it is high time that blind conservatism should no longer stand in the way of equal advantages for New York City.

When the safety with which fuel oil can be stored and used for heating and power purposes and the immunity from any special danger of fire or explosion that has been experienced in other cities were brought to the attention of the Board of Standards and Appeals, steps were taken to appropriately amend the existing regulations, and on September third the board held a public hearing on a tentative draft of amendments of rules governing the storage and use of fuel oils and the construction and installation of oil-burning equipment. The hearing developed the fact that while the proposed modifications of existing regulations respecting the storage and use of kerosene and more volatile liquid fuels for domestic and manufacturing purposes were wise and necessary for public safety, the same general restrictions applied to heavy fuel oil would make its use prohibitive, mainly from difficulties arising from requirements of storage tanks.

Guided by suggestions supplied by the American Society of Liquid Fuel Engineers and the representative of the National Board of Fire Underwriters, the Board of Standards and Appeals will revise their tentative draft of proposed rules and have held a number of public hearings on the subject.

In order that there may be as little obstruction as possible to delay installation and use of fuel-oil equipments, it is expected that the board will request the Board of Aldermen to pass an ordinance at an early date, permitting the use of fuel oil in heating and power plants provided the methods to be employed are in accordance with plans filed with and approved by the Board of Standards and Appeals.

The Synchronous Motor Coming Into Its Own

IN ITS general construction a synchronous motor is an alternating-current generator operated as a motor. However, to give the machine stability in operation and make it capable of developing considerable starting torque, it requires a squirrel-cage winding in the pole faces. As the machine was first constructed and operated, it was very unstable, having a marked tendency to hunt, and was affected by disturbance in the system. This hunting frequently became serious enough to cause the machine to fall out of synchronism and stop. On account of its low starting torque this machine also required an auxiliary source of power to bring it up to speed so that it could be synchronized as an alternator before connecting it to the line, after which the mechanical load was thrown on through a clutch and the source of auxiliary power cut out. If all these operations were properly made by an expert attendant, the motor was put on the system without any serious disturbance. When the complicated operation of this early-type synchronous motor, and in many cases its unsatisfactory performance, was compared with the squirrel-cage motor, which in small sizes could be started by throwing them directly across the line or in the larger sizes required only an auto-transformer connected to a double-throw switch for starting, it is obvious how the former type was soon practically disregarded as a medium of converting electrical energy into mechanical.

This bad name that the early synchronous motor developed for itself still remains with it in many cases. Users of power are not infrequently met who feel that the synchronous motor is the same trouble maker as its early-day predecessor. They still have in mind a motor with a poor starting torque, requiring an auxiliary starting equipment. To put clearly before its readers what a modern-type synchronous motor will do and will not do, *Power* is going to publish a number of articles treating different aspects of this subject. The first of these appeared in the issue of September second. In this way it is hoped to give the reader an opportunity to familiarize himself with the characteristics of this type of motor, which is coming into extensive use for certain types of drive and will no doubt be an important factor in the future application of alternating current.

The squirrel-cage type motor must always operate at a lagging power factor, being about eighty-five per cent. at full load of the motor and decreasing rapidly as the load decreases. Where a number of partly loaded induction motors constitute the load on the system, the power factor must be low. The power factor of the synchronous motor can be controlled by the field excitation. By increasing the field strength above that to give normal excitation of the motor, it can be made to compensate for the low power factor of the induction motors on the system. There is little doubt that the power-factor correcting characteristics of the synchronous motor will have a far-reaching influence in its wider adoption.

A number of the central stations have a power-factor clause in their contracts, penalizing for low power factor, which, in the light of modern electrical engineering, is justifiable. One of the reasons for not introducing this power-factor clause more generally is the lack of some standard definition of power factor and method of measuring it on unbalanced polyphase systems. However, a joint committee of the A. I. E. E. and the N. E. L. A. have the defining of the power factor on polyphase circuits, both balanced and unbalanced, and the recommending of some standard of measuring power factor under consideration. There is little doubt that this committee will report favorably on some standard definition for and method of measuring the power factor on polyphase systems, after which it is probable that the power companies will give greater consideration to what the power factor of their customers' loads are. Therefore it is of interest to those who may have power-factor correction problems to solve to give the subject serious consideration at this time.

Importance of Intelligently Blowing-Down Boilers

THE subject of blowing-down boilers is one which, in many cases if not in most, is treated far too lightly from a standpoint of boiler efficiency. In many plants throughout the country the question has been asked, "How much water do you blow out of your boilers daily?" Invariably, the answer has been, "I don't know, I've never measured it." Further questioning has disclosed the fact that the attendant usually blows down a gage or two every shift, but has no definite idea as to the amount or its effects, working mechanically, much the same as a man winding a clock. It is this lack of information on such a vital subject that results in a great deal of the trouble experienced by plant owners from what is generally called "priming."

Through the standardization of water columns and their fixtures, it has become a habit to call a gage of water a gage, and without further thought on the matter, if the plant to be operated has more than one type of boiler and the attendant is told to blow down two gages every twelve hours, he inadvertently discriminates against one or the other of the boilers. For example, the old-fashioned horizontal return-tubular has a much greater water-holding capacity in the shell situated in a horizontal plane opposite the water column than that furnished in a well-known type of vertical water-tube boiler, and the blowing down of a gage of water in the former would get rid of twice as much of the concentrated impurities as would be discharged from the latter.

A study of the matter will disclose the fact that, barring boilers of the same type and size, there are no two boilers designed with the same ratio of water-holding capacity represented by blowing down one gage to that of the water-holding capacity of the entire boiler, and as these ratios increase or decrease, so does the tendency of the boiler to prime in a given time follow suit.

With the foregoing condition facing the plant owner, he should have a chemical analysis of the raw and also one of the concentrated water made to arrive at the limit of impurities his particular case will stand and then figure just how many pounds of makeup water he will have to replace through blowing down each shift to dilute the remaining mass of water to a point where it will not prime. This information can be readily reduced to a certain number of gages to be blown down so many times a shift.

In this way and only this can the owner rest assured that he is getting the best results from all standpoints.

Will improving low power factor pay a dividend to the power user? is a question that is of serious concern to many power consumers at the present time. In our report on the twelfth annual convention of the Pennsylvania Electric Association, published elsewhere in this issue, are given the results of an investigation into a one thousand kilovolt-ampere load having a power factor of sixty per cent. Installing a static condenser on this system to raise the power factor to ninety per cent. would result in a saving that would pay for the installation in two and one-half years. These figures indicate that in many alternating-current industrial plants the wide-awake engineer may find that it is possible to effect considerable saving in the cost of power by improving the power factor of the load.

In testifying before the Senate committee which is investigating the coal situation, Francis S. Peabody contended that the coal operators are doing their best to hold down coal prices, that in certain sections they could easily get a dollar more per ton, but that they are afraid further advances might lead to nationalization of the coal mines. A frank statement, upon which the consumer will offer thanks for the beneficence of the operator, but at the same time rejoice that there yet remains one force that the latter fears.

How many engineers ever gave real serious thought to the value of a draft gage in the boiler room? How many have found them worth while, and why? How does an engineer know by the reading of such an instrument how and whether the proper amount of air is going into the furnace? How many have noted a saving after installing a draft gage, and how much was it? These are questions worth looking into, and if no attention has been paid to the value of draft gages, it is time it was done.

Smoke prevention received a serious setback during the past two years on account of coal conditions and the necessity of devoting all attention to forced production while the war lasted. Now that normal conditions are returning, efforts may again profitably be directed to the smoke problem.

What does accounting do, that power stations may benefit by it? It is an analyzer of business, that shows where and how the plant is making or losing money. And the most important part of it is, that one can find out at the same time *why* one is losing money.

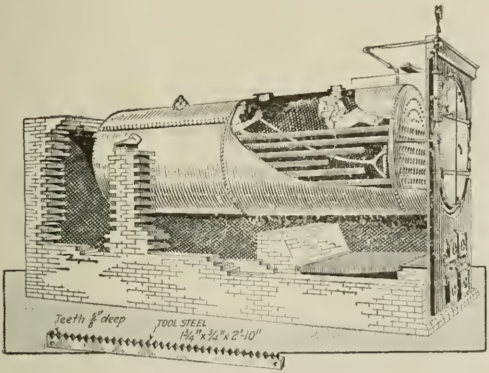
There are many ways of doing any given thing, but relatively few good ways and only one best way. Good methods suggest better methods, and the better methods lead to the best method, which is the goal—Success.

Ambition counts. A man neither rises above his highest thought nor falls below his lowest desire.

· Correspondence ·

Tool for Removing Boiler Scale

Considerable trouble is experienced in boiler plants due to the accumulation of scale between the tubes and on the boiler head and it is usually a difficult task to remove this by mechanical means. A tool that I have designed and used for some time has proven its worth. I use it for removing the hard scale that accumulates between the tubes and on the head of return-tubular boilers and I have not had a leaky tube since I made and used the tool.



APPLICATION OF SCALING TOOL

The tubes on our five boilers are very close together and we found it was difficult to wash out or scrape out the scale between the tubes and around the heads. This tool certainly makes play out of the work now. The head is steel, $1\frac{3}{4}$ in. thick and 2 ft. long. On one side are teeth which are $\frac{5}{8}$ in. deep. The head is set in a frame the handle of which is 5 ft. long and curved.

In operation, the tool (see illustration) is let down between the tubes by means of a chain and by adjusting its length, the toothed side of the tool is swung toward the head and a few hard blows with it causes the scale to loosen and fall to the bottom of the boiler.

Kaukauna, Wis. CHARLES O. KUDER.

Valve Disks from Carbon Brushes

The following hints are for making use of worn-out carbon or graphite motor brushes. I used to have to replace the long disks on the water column try-cocks about every two weeks. They were made of hard rubber and used to buckle from the heat.

The disks on the top try-cocks gave the most trouble. Knowing of the heat-resisting quality of carbon I made new disks out of the carbon brushes and solved my try-cock disk troubles.

On several occasions I made valve disks of worn-out brushes, also steam radiator air-valve disks, which gave good results. FRANK ZAVATSKY.

New York City.

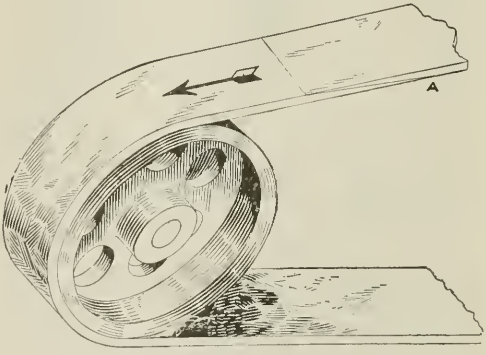
Why the Arrow on Belting?

Manufacturers of leather belting frequently stamp their belts with an arrow designating the direction in which they should be run. It is my understanding that, if the belt is run as indicated by the arrow, the thin edges of the splices next the pulleys, point *A*, will be the last point of the splice to reach the pulleys.

The usual reason given for running the belt in this direction, is that it prevents the possibility of the splice edge being pulled loose and curled up, due to the friction between the belt and pulleys.

It would seem at first glance that the running of the splices as shown in the illustration is correct. It would be if the pulleys were stationary and the belt sliding over them. However, if consideration is taken of the relative velocities of belt and pulleys, it appears to render the question of direction one to be solved for each individual drive.

Owing to the slipping of the belt, the driving pulley face runs faster than the belt and the belt faster than the driven pulley face, so that the action is as if the belt were slowly pulled backward over the driver pulley and forward over the driven pulley. The result is, that no matter in which direction the splices are run, they will run onto the face of one of the wheels in the wrong direction.



WHICH WAY SHOULD THE SPLICE RUN?

If the foregoing analysis of the action is correct, it appears that before the application of a belt, the probable relative slipping of the two pulleys should be determined, taking into account arcs of contact, coefficients of friction and radii, and the splices run in favor of the pulley that is expected to slip the most. If the driver leads in the slipping, the points of the splices next to the pulleys should lead onto the pulleys; but, if the driven pulley is the greatest slipper, the points of the splices should follow onto the pulleys as shown. M. W. DAVIDSON.

Vermilion, S. Dak.

The Maximum Length of a Longitudinal Boiler Joint

The question of a longitudinal joint asked in the July 1 number of *Power* is a good one and should set some boilermakers, engineers and inspectors to studying one of the principal features of boiler design.

In the early days when the rolling mills could not roll wide plates, it was necessary that steam boilers be made in short courses, resulting in numerous girth seams. The girth seams that were over the fire, especially those near the bridge-wall, usually developed fire cracks which in time would cause leakage and necessitate frequent patching.

The placing of a patch frequently resulted in having two joints exposed to the fire instead of one, and the judicious use of the drift pin in the early days consisted of "A two hundred pound boilermaker swinging a 16-lb. sledge at the pin," and was the cause of fire cracks galore.

The numerous girth seams gave considerable trouble. so when the mills were capable of turning out wider plates, some boiler designer struck upon the idea of eliminating the girth seams over the fire. In some of the older engineering books this type of boiler was described as "seamless over the fire," and was considered a good design; and, with reference to the elimination of the fire cracks it was. Boilers were built having one top and one bottom sheet, two top and one bottom, and three top and one bottom sheet.

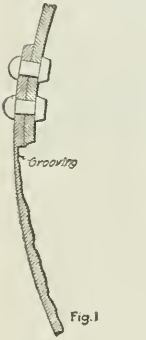
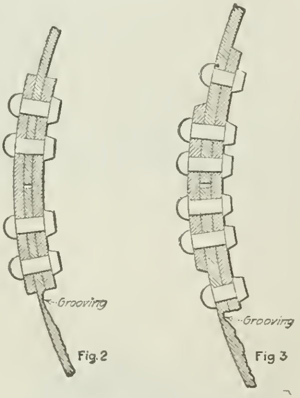


FIG. 1. CORROSION OF PLATE ON EDGE OF LAP-SEAM JOINT



FIGS. 2 AND 3. EFFECT OF GROOVING NEXT TO LONG LONGITUDINAL BUTT STRAP JOINTS

Some of the leading insurance and inspection companies did not approve the above designs, claiming that boilers should have some girth joints, as each girth joint served as a band or hoop and added strength to the boiler; and the test of time has proven this to be true. There are on record a number of disastrous boiler explosions of this single-sheet bottom type of boiler.

An article was published in *Power* May 19, 1908, which should be read by those in favor of long longitudinal seams, or the elimination of girth joints. This article shows the results of tests made on a boiler which was built especially for a test of the relative merits of the different types of joints and illustrates very nicely the strengthening effect of the girth seams which act very much the same as the hoops on a barrel. The changes of temperature and pressure that steam boilers are subjected to cause expansion and contraction of the material, or what is termed the breathing action of the boiler.

Where corrosive feed water is used in boilers having long longitudinal seams, these boilers are very susceptible to grooving. Grooving is a combined chemical and mechanical action. The mechanical action is the breathing of the boiler, and causes minute cracks to develop in the shell plate close to the edge of the inner lap of the longitudinal seam. The acids in the feed water enter the cracks and attack the material, the flexing or bending of the plate continues to take place with the changes of temperature, and the corrosion continues and keeps advancing into the material, until the result may be as shown in Fig. 1.

It is known to the sorrow of some engineers and others, that the long longitudinal lap seam has proven itself a first class helper in the development of longitudinal lap cracks in steam boilers.

Long longitudinal butt-strap joints should not be encouraged, for grooving can take place under this type of joint as well as along lap joints. Figs. 2 and 3 show where this type of joint may be affected.

I believe it fair and just to compare a steam boiler with a beam. An 18-ft. boiler having continuous longitudinal seams and no girth joints is a parallel to a beam 18 ft. long and supported at both ends. A boiler having one girth seam midway of its length would compare with a beam supported at both ends and also in the center. A three-course boiler having two girth seams would be as a beam supported at each end, and also having two additional supports equidistant under it. Give me the short course for strength and safety and courses of 8 ft. would be preferable to 12 ft. courses in horizontal return-tubular boilers of the larger diameters.

Let every member of the *Power* family, who knows boilers, enter into this discussion, as it is well worthy of all the attention that can be given it.

Mt. Oliver, Penn. N. Devering.

Regarding the subject of the maximum length of longitudinal joints, few if any mills are prepared to roll plates more than 12 ft. wide. Plates of this width or greater are not uniform in structure and are not so reliable as narrower plates. I believe that the width of reliable boiler plate is reached at less than 12 ft. and I should say that 8 ft. is the limit in width. This may be contradicted by some plate manufacturers. This limitation is one that is not likely to be overcome by improvement in machinery or process. This then leads to placing the sheet lengthwise of the shell or drum for seams longer than 12 ft.

The tensile strength of plate being less at right angle to the direction of rolling, or crosswise of the fiber, and its ability to stand bending both from rolling into shells and the breathing action in service, is even less. This accounts for the fact that a large number of the horizontal-tubular, two-sheet, full-length, longitudinal-seam boilers built about twenty to twenty-five years ago have exploded from lap cracks of the full-length longitudinal seams.

It is certainly impossible to make a long riveted joint as strong as a short one, on account of the strain set up by the riveting. Although the rivet holes are drilled from the solid, there is a buckling strain developed as the rivets are driven, which is multiplied by an increasing length of seam. This is because the longer seam is more difficult to calk tight and the more likely to leak in service.

As to why the Massachusetts and A. S. M. E. rules differ in regard to longitudinal seams, it is difficult to say; it is certainly not to be accounted for in fact.

No doubt the portion of shell exposed to the fire is under greater strain than that portion not so exposed, and the shells of locomotive boilers are called on to share most of the strains carried by the engine frames, in addition to pressure and shock from service, with most of them working at a factor of three and four, as against five in stationary practice. It would certainly make for safety to limit all longitudinal boiler seams to 8 ft. regardless of type of seam or boiler.

Richard City, Tenn. T. J. BLOSS.

The limit of from 10 to 12 ft. as the maximum length of longitudinal joints in certain types of boilers was no doubt established as a result of the numerous explosions of boilers apparently due to the long joint, of the lap type.

The butt double-strapped joint, it would seem, has overcome the difficulty experienced with the lap joint, and if in spite of the tests required by the A. S. M. E. Code to be made on specimens cut from the sheet parallel with the circumferential seams, there is still any doubt as to the safety of a longitudinal joint longer than 12 ft., then the various bodies of interested engineers ought to get together and prescribe tests which, when made, will determine beyond any question of doubt the safe maximum length of joint.

W. C. HECKEROTH, Chief Engineer,
Erie, Penn. Erie City Iron Works.

Superheated Steam—Why Not?

In the issue of July 1, page 23, there appears an editorial entitled "Superheated Steam—Why Not?" This editorial is on a subject very close to my heart, as I have been associated with a company that has pioneered in the construction of superheaters in this country and I have had to do with this pioneering for over fifteen years. Certain statements in the editorial can be so easily misunderstood by one who has not had experience with superheated steam that I feel the editorial should be answered.

In the first part it is stated that the average engineer considers that the use of superheated steam is confined to the steam-turbine power plant, or one equipped with reciprocating engines of the poppet valve type and that it is assumed that perhaps only 30 per cent. of the total horsepower of engines and turbines in this country use superheated steam and of this most of the use is confined to steam-turbine plants.

This assumption, from my own knowledge of superheater installations throughout the country, is far from correct. There is at present a very large horsepower of Corliss and slide-valve engines operating on superheated steam. It is true that superheated steam is not used in many of the smaller plants, but it may be said that in the larger and more important installations, a very large proportion of these plants use moderately superheated steam for Corliss and slide-valve engines. Even among the smaller power plants very many of them use superheated steam.

Following this, the editorial brings up two arguments that are advanced against the use of superheated steam for reciprocating engines; namely, difficulty of lubrication and the use of metal in cylinders and valves not suited to high temperatures. It asks the question whether suitable oil is procurable for high-temperature steam; the answer to this question is decidedly "yes." It also asks the question whether it is not more a question of maintenance and operation of engines rather than poor metal that causes trouble with lubrication. The answer to this question is yes and no, and which answer is correct depends largely upon the amount of superheat used. There are certainly engine cylinders and valves that I would never recommend for the use of high superheated steam, although I would strongly advocate the use of moderately superheated steam. It is a case of killing the goose that lays the golden eggs to put too high a superheat upon an engine or pipe line not suited to such high-temperature conditions. There is such a splendid saving from the use of superheated steam in moderation that there is no need to go to dangerous temperatures in order to obtain certain desired results. Superheated steam should certainly be used for reciprocating engines of the Corliss and slide-valve type, as these types of engines will show a very large saving with 75 to 100 deg. superheat, but to go to temperatures of 200 to 250 deg. superheat, mentioned in the editorial, would result in all kinds of trouble.

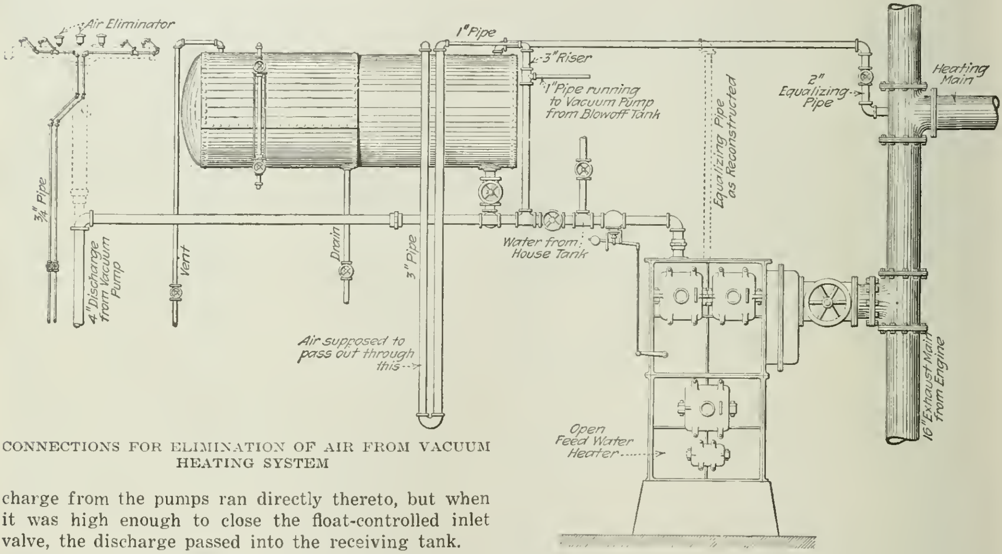
In connection with this statement as regards the use of 200 to 250 deg. of superheat a manufacturer of superheaters is quoted who claims the application of over 18,000,000 hp. in the stationary, marine and locomotive fields. There is only one manufacturer of superheaters outside of the one with which I am associated that could make a claim of this kind as to horsepower in the various fields mentioned, and this company's business has been practically entirely in the locomotive field where conditions are entirely different from those found in stationary practice. Two hundred to 250 deg. of superheat is commonly used in connection with locomotive superheaters. The locomotive has no piping system to maintain comparable with the piping system of the stationary power plant, neither have locomotives Corliss valves, and where they have slide valves these are changed to piston valves when superheaters are installed. The same company has installed superheaters in the marine field for highly superheated steam, but these engines also have no Corliss and slide valves on their high-pressure cylinders. When this manufacturer has had some experience in the stationary power-plant field, he will change his mind.

This answer to the editorial, coming from one who has made a study of superheated steam for a great many years and who is a strong advocate of the same, may, perhaps, seem strange, as the editorial undoubtedly intended to point out the advantages accruing from the use of superheated steam for reciprocating engines of the Corliss and slide-valve types. I feel, however, that many readers might be misled into considering high superheat for this type of engine and wish to do my part through publicity to correct any misapprehension that might be gained by reading the article, at the same time wishing to bring out as strongly as possible, the value of superheat in moderation, for such engines.

New York City. ROBERT H. WYLD.

Separating Air From Returns

Piping systems for various uses in a power plant are often designed in a way to baffle the understanding of an engineer who tries to figure out on his own account what the designer was driving at. For example, consider the situation, in regard to the returns from the vacuum heating system, that confronted an engineer who had newly assumed charge of an office-building plant. The condensation returning from the different floor sections into which the heating system was divided came down to the vacuum pumps in the basement through a system of drop risers connected to an 8-in. manifold, with condensing chambers intervening between the manifold and the pumps. The cooling water injected into these chambers was regulated so as to make up the full quantity needed for feeding the boilers. The discharge from the pumps passed through a 4-in. pipe that branched one way to the feed-water heater and another way to a 5 x 14-ft. overhead receiving tank. Thus, when the water was low in the heater, the discharge from the pumps ran directly thereto, but when it was high enough to close the float-controlled inlet valve, the discharge passed into the receiving tank.


Air Eliminator
1" Pipe
3" Riser
1" Pipe running to Vacuum Pump from Blowoff Tank
Equalizing Pipe as Reconstructed
2" Equalizing Pipe
Heating Main
3/4" Pipe
4" Discharge from Vacuum Pump
Vent
Drain
3" Pipe
Air supposed to pass out through this
Water from House Tank
Open Feed Water Heater
16" Exhaust Main from Engine

CONNECTIONS FOR ELIMINATION OF AIR FROM VACUUM HEATING SYSTEM

From a nipple in the top side of the tank a 3-in. pipe ran out horizontally for some distance, turned down to the floor, and then looped up to the height of the ceiling, where it branched horizontally into a 1-in. pipe that connected to a 3-in. riser from the discharge branch running to the feed-water heater. From a tee near the upper end of this 3-in. riser a 1-in. pipe ran out and connected with the vapor pipe rising from the blowoff tank in the boiler room. These details are shown in the drawing. The engineer finally concluded that this bit of piping was something in the way of an air-expelling apparatus. The air that was pumped out of the heating system was supposed to separate from the water in the receiving tank and seek this route to the outer atmosphere.

From another nipple in the top of the receiving tank a 2-in. pipe ran across and connected to the main supply pipe of the heating system, exactly where the heating main branched out from the main exhaust pipe. What good purpose this pipe was intended to serve was a question that especially puzzled the engineer. Was it put there to transmit the initial pressure in the heating system to the overhead receiving tank and thus neutralize whatever retarding effect the pressure in the feed-water heater might have on the flow of water thereto? If so, why was the tank connection not made to the top of the feed-water heater?

However, it was easy to see that whatever the designer's intention may have been, this 2-in. connection worked perniciously in two ways. In the first place all the air that was given up by the water in the receiving tank quite naturally sought this short cut right back into the heating system instead of following the route that had been laid out for it; and in the second place, if those in attendance did not keep the water level at a safe height by means of the drain valve, the receiving tank was likely to fill up and send a slug of water through this 2-in. connection into the engine exhaust pipe. This did happen on at least two occasions.

To make a good job of all this, the engineer first devised proper means for getting rid of the air displaced by the vacuum pump. His device consisted mainly of a 6-in. riser from a tee at the point where the discharge pipe branched horizontally, the upper end of the riser connecting midway to a header pipe 5 ft. long and 4 in. in diameter. In the top side of the header were inserted three 1-in. nipples, to each of which was attached a patented air eliminator; also, two ¾-in. bleeder pipes, with four connections to the header, were run down to within a few inches of the floor. These were for convenience in relieving the system of unusual quantities of air, as when putting it in service after an overnight shutdown. The next improvement was to disconnect the equalizing pipe from the heating main and bring it down to the feed-water heater. These details are shown by the dotted lines.

After remodeling other features of the piping installation to his own satisfaction, the engineer found that he had a good many feet of fairly good second-hand pipe available for various uses. A. J. DIXON.

St. Louis, Mo.

Engine Crosshead Pounds

In regard to the trouble experienced by Mr. Hollis with his engine, perhaps my experience may be of some help. The two accompanying diagrams were taken during my "doctoring" process, which will bear me out in my contentions and which also coincide with the editor's opinion as per his footnote regarding the compression on Mr. Hollis' engine.

Upon assuming charge of this particular engine, a 26 x 48-in. Corliss running over at 85 r.p.m., I found it running badly, and my predecessor told me that the bearings had to be adjusted very closely, especially the wristpin brasses, which, he said, needed taking up every day. He had no indicator, but I induced the company to furnish one and upon indicating found that the valves were in poor adjustment. I therefore set them as conditions seemed to warrant, and a smooth-running engine was the result.

When I showed the diagrams to the chief engineer of the company, he tried to persuade me that I was running too much compression, which is theoretically correct, but to prove that I was right in making an exception with that particular engine, I moved the exhaust eccentric back to where it was in the first place and no triphammer could make a worse noise than did that engine. The noise was all on the head end, as in Mr. Hollis' case, and a diagram showed an even setting, but with very little compression. When I lengthened the exhaust rod to a position that gave the diagram shown in Fig. 1, the engine ran noiselessly, which shows that no compression was required on the crank-end to prevent the pound, but with such unequal compression the engine did not run steadily, so I went back to my former setting, which produces the diagram shown in Fig. 2, and I have as well-behaved an engine as ever ran. The real trouble is caused by a mechanical imperfection in the engine which cannot be located without stripping and doing a careful job of lining up.

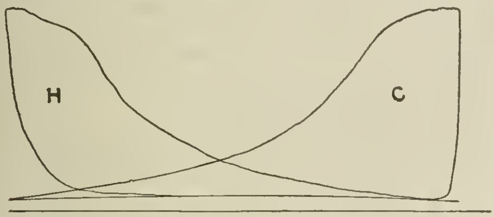


Fig. 1

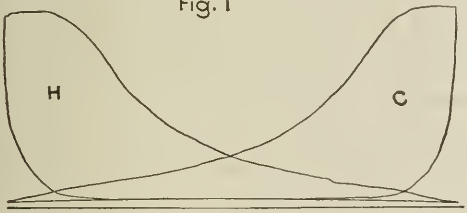


Fig. 2

FIG. 1. NO COMPRESSION ON CRANK END. FIG. 2. COMPRESSION ON BOTH ENDS

My opinion is that the theoretical dead centers are not the actual ones on this engine, which is proved by the fact that the engine requires no compression on the crank end but considerable on the head end.

I believe that the trouble with Mr. Hollis' engine is much the same as was mine, and of course, as his engine runs under, the crosshead could help out on the chorus by slamming down on the lower guide if there is any play.

If any engineer takes exceptions to my views as set forth, I extend to him a friendly challenge to visit my plant and determine whether I am right, and if he wins I will have learned something and will pay his expenses, otherwise he bears his own. L. M. Reed.

Webster, Mass.

Scale Formed in Safety Valve

It used to be general practice in power plants to let the steam from the safety valve on the boilers discharge into the top of the boiler room. To overcome the disagreeable condition thus caused a pipe was extended from the safety valve until it projected through the roof of the boiler room.

With a long pipe going up through the boiler-house roof there is bound to be some condensation of the steam when the safety valve blows off. This condensation is supposed to flow out through a small hole drilled by the manufacturers in the valve body. For a while this hole performs its function, but in time becomes plugged up with scale. Then the condensate has no chance to escape from the valve and it forms into scale. This attacks the valve parts and the spring becomes corroded, and I have had to spend much time with a hammer and chisel cleaning the scale from the springs. The valve stem also becomes corroded in the dashpot, which is not a desirable condition, since the valve stem should work freely. The lower part of the valve stem is also attacked by the corrosive action, right under the spring, and I have taken out stems that were corroded halfway through. Have any *Power* readers had any such experiences as related, and what have they done to remedy them? Thomas M. Gray.

Bayonne, N. J.

Boiler-Tube Failures

There are some good practical points in Mr. Weaver's article on "Boiler-Tube Failures," in *Power* of June 10. Every reasonable man will agree with his conclusion that "nothing can be gained by snap judgment; it is a matter of careful analysis and good judgment to prevent the loss of tubes in water-tube boilers." Mr. Weaver's points on the importance of looking for oil in condensate and on the proper construction of furnace and baffles to prevent a blowpipe flame action are well made.

There is no doubt also that the majority of tube failures are caused by the accumulation of sludge or scale in the tubes. But it is where Mr. Weaver tries to explain how such scale and sludge can be prevented that it is hard to follow him. He is clear and correct when he argues against loosening up old scale by adding compounds that cause the broken old scale to drop down and bake together again on the lower tubes. But after condemning all such compounds, he finds the cure in a so-called "treatment" which he purchases and has a "caustic base." By changing from the common name of "boiler compound" to the more fancy term "treatment" and using the vague description "having a caustic base" Mr. Weaver feels reassured. What does this "having a caustic base" mean? If he means containing caustic soda, why does he later condemn the excess of soda ash left in water softened by the lime-soda process? Soda ash and caustic soda look very much alike after a while under high temperature on the inside of a boiler.

The best that can be expected of a caustic compound at all is that it forms sludge instead of scale. But according to Mr. Weaver's own statements sludge is also harmful. It is the nature of all caustic compounds to cause this; it cannot be prevented by selecting the compound, but rather, it is the treatment with compounds altogether that is at fault. The trouble is that when any caustic compound is added, the tubes and belly of the boilers are used for the reactions that should take place outside of the boiler.

Since all hard water causes sludge or scale, and admitting that boiler-tube failures are caused in most cases by this sludge or scale, as Mr. Weaver stated, then the only real cure is to soften the feed water; that is, to remove the constituents in the water which cause the sludge or scale before the feed water reaches the boiler.

Users of compounds often excuse themselves by stating that lime-soda water softeners were so difficult to operate when it is so easy to put compound in a boiler. Mr. Weaver added another argument against softening plants, "the excess of soda ash" when stating the following: "My theory is that such an excess causes the water to foam," etc. He does not mention what he considers under "such an excess." The fact is, a softening plant can be so operated that there is no greater excess of "caustic bases" left in the water than the amount put into the boiler as compound. The correct application of the "safety first" measure requires an attendant who can properly operate the plant and its auxiliaries. However, a modern system of water softening is available and is simpler even than using compounds. When this zeolite softener is used, the water just flows through a closed or open shell containing the zeolite and the scale-forming salts in the water are automatically exchanged for soluble sodium from the zeolite. No scale or sludge is formed, and no excess of reagents can be introduced into the boilers.

S. B. APPLEBAUM,

New York City.

The article on "Boiler Tube Failures," by Waldo Weaver, page 88 of the June 10 issue of *Power*, applies more to other parts of the country than it does to New York City. We have been extremely fortunate in being supplied with water which, for boiler purposes, could hardly be excelled.

However, I think Mr. Weaver is somewhat pessimistic regarding tube failures, especially from what is called "floating scale." Several years ago I had a similar experience with loose scale, and it was mainly due to the refusal of the chief engineer to allow the boilers to be turbined because of a shortage of boiler capacity. Finally, a broken condenser tube filled the boilers with salt water, and before we knew it the lower row of tubes in four boilers—84 tubes in all—were bagged and leaking. Each tube showed the same cause, a pile of floating scale over the failure. After the boilers were properly cleaned, no further trouble was encountered, although they were forced above rating.

I agree with the theory that tubes burn out owing to the formation of a steam pocket, but I have always found a coating of scale in the defective tube afterward. One of the largest plants in New York City operates its boilers normally at 200 to 300 per cent. rating, but leaves a boiler in service only about two weeks and keeps the lower rows of tubes clean. I believe the late H. G. Stott, superintendent of power of the Interborough Rapid Transit Co., was a firm believer in keeping boilers clean and free from scale and driving them the limit, which, with a forced-draft underfeed stoker, is pretty high.

Graphite will certainly loosen the scale but I do not think it is detrimental to boiler tubes if handled properly and carefully. The doses to feed boilers advocated by the manufacturers of this product are intended to get the scale out of a boiler in "jig" time, and they usually do. A badly scaled boiler is no place for graphite or any other mechanically acting boiler compound, unless the boiler is driven extremely easy and inspected often.

The subject of boiler-water treatment both inside the boiler and out has been ably treated in various publications. The basis of most feed-water treatments is soda ash or a combination of soda ash and lime. Incidentally, there is enough chemistry on the subject in these papers so that an engineer can learn how to test water for these treatments, and then use this as a starter in solving his own troubles.

I have found a combination of soda and graphite best for my own plant and advocate something like this: First, thoroughly clean the boilers, then feed soda ash daily or often enough to keep the alkalinity about the same. Feed a small amount of graphite at regular intervals and blow down the boilers regularly, also, look out for loose scale by frequent inspections. I admit that the foregoing may sound rather vague, but each plant is different and in practice it will work out satisfactorily. The soda will help the graphite to loosen the scale, and if this treatment is followed good results should be obtained. I do not, however, advocate this as a cure all, but with average conditions it will work well.

Graphite has been condemned. In fact, in my own plant the boilers, I was told, were in terrible condition due to its use. This, as I found out afterward, was due to cylinder oil that entered the boilers from a defective feed-water heater. The graphite mixed with this and formed a plastic substance, which was dangerous, as it adhered to the tubes. Repairing the heater and adding soda-ash treatment to the graphite corrected the trouble. Any plant engineer who has and uses oily returns, etc., in his boilers must be extremely careful in using graphite. However, if soda is used judiciously to kill the oil, graphite may be used with beneficial results.

The whole subject may be briefly summed up in one statement, that, barring corrosion, and other conditions being equal, the number of tube failures will be directly proportional to the rate at which boilers are operated. While this is true, however, conditions as a rule vary so much that each case has to be considered on its own merits.

WARREN D. LEWIS.

New York City.

The light output of Mazda lamps decreases slowly with age, but the average output through the life of the filament is a higher percentage of the initial value than that which is obtained by any other illuminant.

Inquiries of General Interest

Relative Capacities of Rubber and Leather Belting—What is the relative transmissive capacity of rubber and leather belting? C. W. C.

When a proper weight of duck is used in rubber belting, four-ply rubber belting is taken to have the same transmissive capacity as good quality, single, thick leather belting of the same width; six-ply rubber the same capacity as double thick leather belting and eight-ply rubber the same capacity as triple thick leather belting.

Testing Surface Condenser for Leakage—How may a surface condenser be tested for leakage? W. B. R.

Probably the best method to determine the amount of condenser leakage is to pass cooling water through the tubes at the normal rate of flow, at the same time maintaining the required vacuum with the air pump. The amount of water removed by the air pump is the leakage of circulating water into the steam space of the condenser. The most general test for determining whether or not there is any leakage is to close all connections and observe whether a vacuum once established can be maintained a reasonably long time. Where salt water is used for cooling, it can be determined while running whether there is any leakage, by adding a little silver nitrate to a small amount of the condensed steam; if there is no appreciable precipitate of white silver chloride, it may be assumed that the condenser does not leak.

Saving from Higher Temperature of Feed Water—Where the boiler pressure is 120 lb. gage, what is the percentage of saving from returning the condensation from heating coils to the boiler at 240 deg. by traps in place of returning the water to a tank and feeding the water at 180 deg. F? P. E. M.

In either case each pound of feed water, when converted to steam at 120 lb. gage, or 135 lb. per sq.in. absolute, would contain 1191.6 B.t.u. above 32 deg. F. When the feed temperature is 180 deg. F., then each pound of feed water for conversion into steam would have to receive $(1191.6 + 32) - 180 = 1043.6$ B.t.u.; and when the feed temperature is 240 deg. F, each pound of the feed water would have to receive $(1191.6 + 32) - 240 = 983.6$ B.t.u., or $(1043.6 - 983.6) \times 100 \div 1043.6 = 5.75$ per cent. more heat. Whether this represents the actual saving of coal from use of the traps, in place of a receiving tank and feed pump, depends on the relative steam economies of the trap or feed pump that may be employed.

General Dimensions of Overshot Waterwheel—What should be the diameter, general dimensions and speed of an overshot waterwheel with flat-sided buckets, to develop 5 brake horsepower with 3000 gallons of water per minute? R. D. M.

The weight of water supplied per minute would be $3000 \times 8.33 = 24{,}990$ lb. A well-designed wheel with flat-sided buckets would have an efficiency of about 50 per cent. For development of 5 b.hp. the energy of the water would need to be $(5 \times 33{,}000) \div 0.5 = 330{,}000$ ft.-lb. per min., and the water would need to be supplied with a total head of not less than $330{,}000 \div 24{,}990 = 13.2$ ft. The surface velocity of the wheel should be about 6 ft. per sec. and the velocity of water supplied on the wheel should be double that, or about 12 ft. per sec., which is due to a head of about 2 ft. 3 in. If the wheel is to receive the water exactly at the top, the summit of the buckets should not be more than 2 ft. 3 in. below the top water level in the penstock, and the wheel should not be less than $13.2 - 2.25 = 10.95$, or about 11 ft. diameter at the periphery of the buckets. Allowing for operation with 3 in. lift of the spout gate and discharge upon the wheel of 3000 gal., or $3000 \div 7.48 = 401$ cu.ft. of water per min., at a velocity of 12 ft. per sec., or 720 ft. per min., would require a gate and inside width of spout of $401 \div (720 \times \frac{3}{1}) = 2.23$ ft., or about 27 in., and about 34 in. length of the waterwheel buckets between the shrouds. For a surface velocity of the periphery of the buckets of 6 ft. per sec., or one-half of the spouted velocity of the water, an 11-ft. wheel should be geared for a speed of $(6 \times 60) \div (11 \times 3.1416)$, or about 10½ revolutions per minute.

Running Clockwise and Counterclockwise—When is an engine said to be running "clockwise" or "counterclockwise"? R. E.

A horizontal engine is said to be "running over" when the crank rises at the beginning of the stroke that occurs while the piston is moving toward the crankshaft or when the top of the flywheel turns away from the cylinder, and the term "running under" is applied to rotation in the opposite direction. Stationary engines usually are designed to "run over," so the pressure between the crosshead and the crosshead guide, due to the angularity of the connecting-rod, comes on the lower side of the crosshead only, and also so the belt, which usually leads away from the engine, will have the driving pull on the lower side. Hence the direction for running over is sometimes referred to as "running forward." The term "running clockwise" usually is intended to mean "running over," or forward, and in the same direction as the hands of a clock to an observer viewing an engine with the shaft to his right hand and the cylinder to his left. The terms clockwise and counterclockwise applied to an engine are often confusing, as the direction will be clockwise to a person standing on one side and counterclockwise to one standing on the other side, and it is best to confine the designations of directions of rotation to the terms "running over" and "running under."

Heat Required for Generation of Wet Steam—What is the formula for determining how much heat is required for generation of a pound of steam at 150 lb. gage and quality 98 per cent. from feed water at the temperature of 120 deg. F.? M. D.

The number of B.t.u. contained per pound of the steam is given by the formula,

$$H_w = h + qL, \tag{1}$$

in which

H_w = Number of B.t.u. above 32 deg. F. in a pound of the wet steam;

h = Heat of the liquid, or number of B.t.u. required to heat a pound of water from 32 deg. F. to the temperature of evaporation corresponding with the pressure;

L = Latent heat of evaporation, or number of B.t.u. contained by a pound of dry saturated steam at the stated pressure, in addition to h;

q = Quality or fraction of a whole pound of the steam that has received the latent heat of evaporation

If t = the temperature of the feed water, then $t - 32$ = the number of B.t.u. contained by the water above 32 deg. F. before any heat is added to it in the boiler; and if x is the quantity of heat required for generation of a pound of the steam, then

$$x = H_w - (t - 32) = H_w + 32 - t \tag{2}$$

and by substituting the value of H_w in (1),

$$x = h + qL + 32 - t \tag{3}$$

For steam at 150 lb. gage, or 165 lb. absolute, the tables of properties of dry saturated steam give $h = 338.2$ and $L = 856.8$. With $q = 98$ per cent. and $t = 120$, by substituting in (3) the heat required is found to be

$$x = 338.2 + (0.98 \times 856.8) + 32 - 120 = 1089.8 \text{ B.t.u.}$$

Pennsylvania Electric Association Twelfth Annual Convention

THE TWELFTH annual convention of the Pennsylvania Electric Association was held at Bedford Springs, Penn., with the Bedford Spring Hotel as headquarters, on Sept. 3 to 6 inclusive. It proved to be one of the most successful conventions held by this association, with 388 members and guests registering. One of the interesting features was the exhibition of 24 electrical manufacturing companies' apparatus. This exhibition was held in a large tent erected near the hotel, and is probably the first time that an exhibition of this kind was held under canvas.

There were three technical sessions, at which nine papers were presented. The first technical session was called to order at 2:30 p.m. on Tuesday, by President Thomas Sproule, The first paper presented, "Increasing Capacities of Existing Lines and Cables," by E. C. Stone, deals particularly with three-phase circuits and discusses the economical possibilities of increasing 2300-volt line capacity by increasing the voltage. It is pointed out that in almost every power-distribution network, where an existing 2300-volt system is sufficiently loaded to require an increase in capacity, it will be found desirable and economical to increase the line voltage to 4000 volts. Ordinarily, the insulation of line and connected installations on a 2300-volt system is heavy enough to stand 4000 volts, so that the only change necessary is to reconnect transformers from delta-delta to star-delta. By changing the voltage of a distribution network from 2300 to 4000, an additional 73 per cent. capacity and a materially better regulation can be obtained at practically no additional cost.

Effect of War on Boiler-Room Practice

The second paper, "The Effect of the War on Boiler-Room Practice," by J. A. Barnard, presented at the Thursday afternoon session, discusses the effect of the war on the boiler-room practice of the Philadelphia Electric Co. It is shown by the curves that the average evaporation from and at 212 deg. was approximately 8.6 lb. of water for a period of four weeks during January and February, 1918, against about 9.9 lb. for the same period in 1919. The curves are shown with the desire to convey the result of two different labor conditions—in the first case, very bad; in the second, a marked improvement in two months after the armistice was signed. It must be remembered that in the early part of 1919 the boiler-room equipment had not yet recovered from the hard siege through which it had passed, and still more encouraging results are expected later. In the conclusion in this paper it is pointed out that "too much emphasis cannot be placed on the appearance of buildings and plants. The surroundings help make the men. At Schuylkill No. 2, and especially at the new Chester station, which was built during the war, the architect has combined the ornate with the economical and substantial qualifications of a modern central station. The casual visitor remarks 'why clothe the revolving generators and steam boilers with such elaborate surroundings'? The answer is given by the operating engineer and the station operating force. The former is proud that his profession is becoming more recognized, and the latter are men of such caliber as will produce better results with clean surroundings that inspire rather than those that depress. Clean, cool locker rooms, with shower baths and modern conveniences, send the retiring shift home comfortable and clean. A completely equipped restaurant provides good substantial food at any hour of the day or night to all employees at less than cost price. So let it be remembered that if you improve personnel and moral first, efficiency and economy will be the inevitable result."

In the discussion on this paper it was brought out that there is a new proposition in the field today in conjunction with an induced-draft fan, being an installation of an air washer on the discharge side of the boiler, to wash the gases, thus eliminating a good bit of cinder before it reaches the stack, and also cooling the gases to a great degree, so that necessity of a high stack is obviated.

As to fuel oil and its possibilities in power plants the opinion was expressed that it seems to be ideal under some conditions, also that fuel-oil burning equipment is much cheaper to install and much easier to maintain, has fewer parts to operate, requires a smaller boiler-room crew, and there are no ashes to handle. However, the one great drawback in oil burning is the existing low rate for coal. If there was any good guarantee that the price of oil would be maintained anywhere near the price of coal, the former would be the ideal fuel.

Pulverized Coal in Power Plants

In connection with pulverized coal it was pointed out that it has some of the advantages that oil has, such as doing away with the stoker and ash-handling equipment, although this is offset to some extent by the equipment for the pulverized-fuel installation. However, it apparently had a margin of desirability in the fuel-burning proposition. It was the opinion that the one drawback to burning anthracite culm by central stations is the necessity of having immense boiler settings to take care of the peak load, but in stations where the load is fairly constant at all times, pulverized coal would probably be very desirable.

"Method of Operating a Meter Department in Scattered Territory," by E. H. Tyson, presented at the Thursday afternoon session, gives a proposed method of operation of the meter department of a central-station company whose lines cover a large scattered territory to enable it to perform its duties under the new conditions in an efficient and economical manner. It is the author's opinion that by the method described it would be possible not only to standardize the organization and methods of the meter department, but also to lay out the work in each division and district in a manner best adapted to its own local conditions.

The report of the engineering committee was also presented at the Thursday afternoon session. This report gives tentative specifications covering the construction of jointly used pole lines carrying electric-supply circuits and signal circuits. The report was prepared by representatives of the engineering committee of the Pennsylvania Electric Association, and the American Telephone and Telegraph Co. This report is an extensive one and, as published, covers 43 pages.

Friday Morning Session

The technical session held on Friday morning was called to order by President Thomas Sproule at 10 a.m., after which four papers were presented. "Economical Boiler-Room Practice for Medium-Sized Plants," by H. D. Bryans, was read by the author. In this paper are described in a general way the equipment installed and methods pursued in the operation of the boiler plant of the Counties Gas and Electric Co., at Norristown, Penn. The author lays considerable stress on the intellectual caliber of the personnel in the boiler room, and in closing his paper says: "In fact, we feel that a first-class head boiler operator, or what might be called a boiler engineer, is of as much—yes, greater—value to the plant as is the shift engineer in the turbine room. It is a hard matter to break down prejudice and tradition, and we have found that the men are prone to look upon the turbine-room engineer's job as their real goal. It is time that the idea that the men in the boiler room are mere coal shovelers or coal burners should disappear. Times have changed in this matter, as in all others, and I believe the time is coming when the goal will be that of the boiler-room engineer and not turbine-room engineer. At Norristown we have never given out bonuses or anything other than straight wages. We believe that local conditions have a great bearing on the success of such plants, and we feel that sure and steady work is better if the proper type of men can be procured."

In the discussion it was brought out that in one boiler room containing eight boilers, 300 tubes had to be removed per year when the feed water was not treated, but the number was reduced to three tubes in one year by the proper treatment of the feed water. Mr. Bryans pointed out that in his plant, where from two to twelve boilers are in operation, by treating the feed water the tube renewals had been reduced to 13 or 14 in three or four years, where before they started to treat the feed water it was necessary to remove whole rows of tubes at a time.

SELECTING SWITCHBOARD FOR MODERATE-SIZED PLANT

"Selecting a Switchboard for a Plant of Moderate Size," by G. E. Wendle, was the second paper presented at the Friday morning session. The author describes the procedure by which the selection of a switchboard for a moderate-sized plant was made for the Lycoming Edison Co., Williamsport, Penn. In order to determine some standard basis for comparison of switchboard types, the following features were considered essential: (1) Reliability of continuity of service; (2) safety to employees and the public; (3) facility of installation; (4) facility of inspection and maintenance; (5) economy in operation; (6) localization and isolation of troubles and consequent damages; (7) time required for resumption of service after any interruption due to the switchboard; (8) first cost; (9) reserve equipment required; (10) provision for future growth. Each one of these features is discussed in the paper.

An extemporaneous talk by H. P. Weaver on "Management of Men" brought forth considerable discussion. From this discussion it was evident that the executives of the central-station industry are giving serious consideration to their employees' welfare and that a great deal of constructive work has already been done toward this end.

The Friday morning session was closed by the presentation of a paper, "The Story of the Insulations," by C. E. Skinner. After a general discussion of the development of insulations, the author divides the subjects into insulating varnishes, mica, transformer oil, molded insulation, glass and porcelain insulators, sheet insulation, the enemies of insulation, and insulations of the future, giving a brief story of each. An abstract of this paper will be published in a later issue of *Power*.

THE SATURDAY MORNING SESSION

President Thomas Sproule called the Saturday morning meeting to order and then called on J. W. Myers to present his paper on "The Isolated Plant Costs as Influenced by the War." This paper is based on the important points developed in the discussion, "The Effect of the War on Isolated Plant Cost," presented at the Atlantic City convention of the National Electric Light Association, held May 19 to 22, 1919. The subject is discussed chiefly from the standpoint of the purchasing power of a dollar. An abstract of this paper will be published in a later issue.

The second paper, "Power-Factor Correction by Means of Static Condensers," by O. C. Roff, was presented by the author. It gives a description of the construction and application of the static condenser for power-factor correction. The cause and the effect of low power factor are discussed, and comparisons are made between the synchronous and static condensers for power-factor correction. In the discussion it was pointed out that a low-power-factor load was a high-cost load and that a synchronous condenser on each motor would be an ideal condition. It was the opinion that both static and synchronous condensers have their own distinctive fields of application; the characteristic of the system determining the character of the power-factor correcting device. It was brought out that Terrill regulators have been used successfully for controlling the field current of synchronous motors when used for power-factor correction. A suggestion was made that a symposium on power factor and power-factor correction be prepared and presented before the Pennsylvania State branch of the National Electric Light Association, in the near future.

In the discussion on Mr. Roff's paper the results of an investigation of the power factor of the loads of a number of large power users were given. This investigation found power factors varying from 45 per cent. in silk mills to 85 per cent. in factories using group drive extensively. A group of large customers averaged 64 per cent., largely owing to individual motor drives on machines requiring very high starting torque. In another investigation of a connected load totaling 1100 hp. at 440 volts, having a maximum demand, on a 15-min. interval, of 612 kw. at 65 per cent. power factor, or approximately 1000 kv.-a., it was found that a static condenser of 540 kv.-a. capacity installed on the system to raise the power factor to 90 per cent. would result in a saving that would pay for the condenser equipment in 2.5 years, not considering the vast improvement in the service to the customer.

The following officers were elected for 1919-20: President, W. R. Kenney, Connellsville, Penn.; first vice president, Henry Harris, Pittsburgh, Penn.; second vice president, E. H. Davis, Williamsport, Penn.; treasurer, H. S. Cantlin, Allentown, Penn. Members of executive committee (two year term): W. E. Long, Philadelphia, Penn.; J. H. Shearer, Altoona, Penn.; G. M. Gadsby, Pittsburgh, Penn. Henry N. Muller was elected to fill out the unexpired term of Henry Harris, who was appointed first vice president.

Convention New York State Branch I. U. S. E.

The New York State branch of the International Union Steam and Operating Engineers held its second annual convention at Syracuse, N. Y., Aug. 24 to 25, 1919. Nearly every local union in the state was represented by one or more delegates.

The convention adopted a number of resolutions favoring legislation which, if enacted, will tend to improve the conditions of the engineers of the state. All resolutions dealing with legislation passed were later in the week introduced in the convention of the New York State Federation of Labor and received the indorsement of that body. Among the resolutions adopted was one to amend the "day of rest" law, making it broader in scope; three weeks' vacation for city and state employees at the prevailing rate of wages; to have all employees of schools of the state paid the prevailing rate.

Consideration was given to license laws, and a resolution was adopted on this subject which provides that amendments to the New York City law must have the approval of the local joint executive board of Greater New York before it can receive the support of the State Branch or the indorsement of organized labor. Recognizing the importance of having the support of the organized workers of New York State in matters of legislation, the State Branch, by unanimous vote, decided to affiliate with the New York State Federation of Labor.

The convention engaged in discussions of many subjects affecting the welfare of the engineers, but particularly the question of wages and hours. After delegates from all parts of the state had explained the dissatisfaction with the present conditions which exists in their several localities, it became the unanimous opinion of the convention that working agreements mutually entered into by the employers and the engineers are the true solution of all differences between them.

Matt Comerford, past general president of the International Union of Steam and Operating Engineers, represented *Power* at the convention, and addressed the delegates at one of their sessions. Local unions Nos. 11 and 545 jointly entertained the delegates and visitors with a degree of hospitality that made everyone feel at home in Syracuse.

John P. Mallody, of Rochester, N. Y., received the unanimous vote of the convention for president of the State Branch, and Frank Lennon of the Bronx, N. Y., was elected State secretary and treasurer.

Suitable solders for aluminum are obtained by the use of tin and some zinc, or by both tin and aluminum within wide ranges of proportions. The solders should be applied without a flux and at high temperatures; the adhesion is said to improve with rising temperature of the tinning operation.—*The Engineer*.

John J. Calahan

John J. Calahan, newly elected president of the National Association of Stationary Engineers, has been prominent in engineering circles for many years.

Mr. Calahan first became identified with engineering in 1890 when he entered the employ of Miller & Bauer Co., machinists. Remaining with them until he finished his apprenticeship, he entered the mechanical department of the Standard Oil Co., later leaving to accept a position as engineer with the manufacturing company of Hanna & Hanna, subsequently rising to the position of superintendent. He remained with this firm until they retired from business. His next position was engineer for the Metropolitan Manufacturing Co., of New York. When the United States declared war with Spain, Mr. Calahan entered the service, being assigned to the auxiliary cruiser "City of Berlin." After returning to civilian life he accepted a position as engineer with the firm of Clarkson & Wainwright. In 1901 he was appointed by the Board of Education engineer in one of the large public schools of Jersey City. When the new Dickinson High School, one of the most up-to-date structures of its kind in the country, was erected in 1904, Mr. Calahan was appointed chief engineer of the building. In 1909 he was chosen by the directors of the board as supervising engineer for the entire school system of Jersey City, a position that required thorough technical and practical knowledge. He has entire charge of the heating and ventilating systems of the schools and has proven his ability by his satisfactory service since his appointment.

JOHN J. CALAHAN

He has ever had the interests of engineers and the engineering profession at heart. His influence was instrumental in obtaining for Jersey City an ordinance for the licensing of engineers—afterward made a state law—which proved a benefit to the engineer and a safeguard to the life of the community. He was elected president of the new license department of Jersey City and continued in that capacity until the ordinance became a state law.

Mr. Calahan has held every office in his local association, is past president of the New Jersey State Association, was state deputy for three terms, United States deputy six terms, chairman of the National License Law Committee at the Denver convention, and has been a delegate from the Jersey City Association to numerous other conventions. He is connected with many social societies, is a member of the American Society of Heating and Ventilating Engineers and the Alumni of the New York School of Heating and Ventilating and is a teacher in the evening classes of Power Plant Operation at the Jersey City High School. During the recent war he again offered his service to the country, this time serving as instructor for the United States Shipping Board Recruiting Service of the Merchant Marine Engineering School. The result of his efforts in this work was that all students graduating from his class did so at such percentages as to merit credit both for themselves and their instructor. Mr. Calahan has done much to advance the welfare of the National Association of Stationary Engineers in the State of New Jersey, and we wish him all the success which is merited by one who has given so generously of his time in the interest of the calling to which he has so conscientiously devoted himself.

Water-Power Development and Public Information Committee Chairmanships

President R. H. Ballard of the National Electric Light Association announces the acceptance of John F. Gilchrist, vice president of the Commonwealth Edison Company of Chicago, as chairman of the Committee on Public Information, and also of Franklin T. Griffith, president of the Portland Railway, Light and Power Co., of Portland, Ore., as chairman of the Committee on Water Power Development. These important committees will have valuable and instructive reports to submit to the national convention of 1920, which will be held in southern California.

The Committee on Public Information is a new one, and Mr. Gilchrist will organize it by establishing in each state or geographical section a local committee, which will finance itself and furnish news bulletins to the press through member companies. Recommendations for appointment as members of the general committee, of men selected as chairmen of committees in various states, will be made by Mr. Gilchrist and will be submitted for approval to the president and to be acted upon by the Executive Committee.

This will be a very large committee, but as its work will be largely devoted to states and geographical sections, it is unlikely that its entire membership will ever be called to meet. Thus its proportions will not be objectionable. Mr. Gilchrist was instrumental in starting a movement along these lines in Illinois which proved very successful. It is believed that to extend it to every state in which company members may desire assistance will accelerate its effectiveness.

The work of the Committee on Water Power Development, which will be under the direction of Mr. Griffith, who will associate with himself prominent executives from all the Pacific coast companies and also some of the executives from Eastern companies, has before it an enormous scope for its activities. The purpose of its organization is to investigate and encourage water-power development, and it is the first general committee of the association to take up this important feature of the electrical industry.

The Department of the Interior, the War Industry Board and other bodies have collected an enormous amount of data in relation to the problems of water-power development. Mr. Griffith's committee will not only collect and codify the information gathered by these bodies, putting it into workable shape for the use of geographical and central states, but will pursue, where there seems to be a necessity, a line of original investigation. The need for conservation of the natural resources of the nation, the impending shortage of both coal and fuel oil and the probability of large increases in the demand for electric energy by partial railroad electrification, make the work of this committee of paramount importance, and its report will be of great assistance in the financing which extensive water development will involve.

A Short Course for Marine Engineers

When the United States entered seriously into the shipbuilding industry and the Shipping Board began delivering vessels for cargo service at a rate never dreamed possible, a brand new difficulty confronted the board; namely, the want of properly trained officers.

This was particularly true of the propelling-machinery staff, for not only were reciprocating engineers needed in large numbers, but since an increasing percentage of vessels were being equipped with the more modern geared-turbine drive, it was necessary for the board to train men to become masters of this new class of machinery.

The solution of this problem lay in the opening of turbine schools where skilled engineers, who have been trained on reciprocating engines or had in some cases limited experience in the handling of turbines, could be given the latest and most approved instruction under the direction of men thoroughly familiar with the construction and assembling of this type of engine.

In order to accomplish this result most effectively, the board communicated with the leading manufacturers of turbines (Westinghouse, General Electric, DeLaval, Kerr and others) and proposed that classes be established at each plant for engineers who would be supplied by the Shipping Board. This proposal was promptly accepted, and the first class was opened at the Westinghouse Works, East Pittsburgh, in 1918.

The school was under the official direction of the board's recruiting service, with headquarters at Boston. The director was Henry Howard, a Boston business man and chemical engineer, who had made a life-long study of marine affairs and was serving the board for one dollar a year. After the school had been in existence a short time, it was placed under the direction of A. A. Gathemann, Supervising Engineer of Turbine Training, United States Shipping Board Recruiting Service, a man of enthusiasm and thorough training as an engineer, who deserves unlimited credit for making this undertaking the wonderful success it has become.

The students for these schools are passed upon by Mr. Gathemann and must be either chief engineers or first assistants. Many candidates apply directly to the recruiting service; others are selected from their staffs by the various ship-operating companies; still others are picked up individually by the recruiting service and the turbine manufacturers, either because of personal acquaintance or through correspondence requesting information as to turbine operation.

During the course of instruction, which averages about six weeks in length, the students receive liberal shore pay, together with traveling expenses and an allowance for sustenance. Upon completion of the course, if the student has attained a satisfactory average for all work done, he is awarded a diploma which, although it has no official status, is ample evidence that the holder is qualified to operate marine turbines. Over 250 students have so far been enrolled.

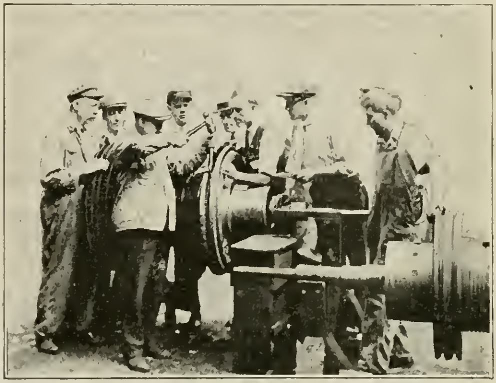
The two principal schools are located at the plants of the Westinghouse Electric and Manufacturing Co., East Pittsburgh, and the General Electric Company, Schenectady, N. Y. All students must take the courses at both of these schools, and then those who are to handle some other make of turbine in the immediate future are transferred to the plant of that particular manufacturer.

The course at East Pittsburgh runs through a period of three weeks and is divided into five main subjects as follows: Small turbine drives; condensers and auxiliaries; main turbines; main reduction gears; and electrical equipment.

First of all, the class is taken into the shop in groups of not more than seven or eight to each instructor, and given the opportunity of seeing all parts of each piece of the various propelling apparatus. Each part is carefully and systematically shown and explained in detail. Great care is taken to explain the reasons of design, where trouble may occur and how to remedy it. The class is also given every opportunity of taking each piece of apparatus apart and reërecting it, so as to make sure they have a thorough understanding of the construction. They also have to actually go over all adjustments on the turbines and do sufficient work on the inserting of turbine blades to know what to do in the case of trouble. On the main gears great care is taken to make the class familiar with all adjustments necessary for aligning and operation.

Supplementing this, lectures are given on each of the foregoing groups in which the practical points of operation are emphasized and fundamental principles brought out. The class is encouraged in every way to ask questions during the lectures, thereby increasing the value of the lecture to a great extent.

A specified time is allotted to each subject, on the expiration of which the answers to the examination questions on that subject are to be written out and handed in. The corrected examination paper is handed back to each student together with a copy of the correct answers. The student's attention is called to the questions he has not answered correctly.



CLASS SETTING BLADES IN TURBINE SPINDLE

The examination papers are all corrected and rated, and a careful record is kept of each student. When the course is completed, this record is forwarded to the Shipping Board, and they then have a true analysis of the student's aptitude and probable ability, which is very useful in finally placing him.

The average class consists of 16 men, usually ranging from 24 to 50 years of age. They bring to the manufacturing company years of sea experience and at times give valuable suggestions to the company's engineers. At all times they keep the company's engineers on the alert to answer their very practical questions. They are all anxious to learn the how and why of the apparatus from the inside, and make ideal students.

According to a report by the Bureau of Census, the electric light and power stations of the United States generated more than 25,000 million kw.-hr. during 1917, producing an income of $500,000,000 and employing more than 100,000 persons. The output for 1917 was more than twice that for 1912 and more than four times that for 1907. These figures do not include private generating plants, but include 4224 company stations and 2317 municipal stations. Though 2296 new establishments came into existence during the period of 1912-17, the net increase was only 1320 owing to combinations and various other changes.

N. A. S. E. Convention at Huntington

THE thirty-seventh annual convention of the National Association of Stationary Engineers was formally opened in the auditorium of the Municipal Building, Huntington, W. Va., at 10 o'clock, Tuesday morning, Sept. 2, by C. L. Humphreys, chairman. The local committee introduced Mayor C. W. Campbell, who welcomed the visitors in the name of the city and expressed the pleasure which the city felt at having been chosen as a meeting place, assuring the delegates that their comfort and enjoyment were the personal concern of every citizen. National President Roderick Mackay acknowledged the mayor's welcome in his characteristics way, stating among other things, that after Collis P. Huntington had done all he could with Huntington, W. Va., he went out to Los Angeles, where Mackay hails from, and built a regular city.

Samuel B. Montgomery, state labor commissioner, told of the resources of West Virginia in coal, oil, natural gas, timber and agricultural products.

Vice President John J. Calahan responded briefly but effectively, following which George I. Neil, ex-president of the Huntington Chamber of Commerce, spoke for that and its associated organizations.

Past National President John Wickert, in an address, emphasized the object of the association as improving, by education, the efficiency of its members and urged the importance of greater efficiency as a factor in the solution of the problems of reconstruction and the reduction of the costs of living. The war had shown, Mr. Wickert said, what could be accomplished by engineers in reducing the cost of power generation, and the efforts in this direction should not be relaxed.

The morning session was concluded by the presentation of a gavel to President Mackay by the local association.

Tuesday afternoon the president's report was read, in which it was stated that the war, the influenza and the aftermath of both had been responsible for some falling off in membership. A recommendation was made that special efforts be put forth to increase the membership of the association through the visits of deputies and national officers and as well by making meetings more attractive. It was also suggested that employers be made honorary members in order that their influence might be available to encourage the attendance of their engineers at all association meetings.

The question of amalgamation with the Canadian Association of Stationary Engineers was brought up by the president, who asked for instructions concerning the appointment of a committee to consider such a step. A legal contract with the National Exhibitors Association was recommended whereby the N. A. S. E. could require an accounting from the exhibitors' association for the purpose of turning over of a stipulated amount of the net proceeds to the N. A. S. E. for entertainment purposes or for any other legitimate expenses, and probably a further percentage for a sinking fund. It also was suggested that a representative of the N. A. S. E. should be placed on the board of directors of the National Exhibitors Association to watch and guard their interests, and the president asked that he be empowered to appoint a committee for this purpose. The resolution was adopted unanimously.

There had been some infractions of Article 21 of the constitution, which prohibits local associations from soliciting advertisements for any other than the association's official paper. These infractions had been dealt with by suspension or reprimand, and any complaint at such punishment was considered by the president to be "poor taste on their part."

National Deputy John J. Calahan urged more interested response from the local associations, the lack of which prevented him from making complete statistical reports. A resolution calling for state organizers was referred to the committee on resolutions. The spirit of the times was reflected in several resolutions intended to amend the preamble of the constitution, eliminating the clause containing the declaration that "this association shall at no time be used for the furtherance of strikes." The resolution, however, failed of adoption.

The secretary's report showed an active membership of 16,380, of which number 272 delegates were reported present by the credentials committee. Including the honorary and associate members, and those who are one year or less in arrears, the total membership would be 20,178. The treasurer's report showed the association to be in good financial condition.

It was recommended by the educational committee that in view of the limited use of lantern slides, no extensive additions are to be made during the coming year to the educational program. It was further recommended that a bulletin be issued on the use and value of exhaust steam and that the question and answer department be continued.

The license committee reported that there has been very little sentiment for license legislation manifested by the organization during the past year. Bills were presented in the legislatures of West Virginia, Illinois and Iowa, none of which was successful. It was reported that Kenosha, Wis., has adopted an ordinance providing for the licensing of stationary engineers.

Tuesday afternoon a paper on national water power conservation, by Thomas J. Royer, of Los Angeles, Cal., was presented in his absence by H. R. Hilton.

Wednesday morning, John Lane, editor of the National *Engineer*, the official publication of the association, presented some thoughts on the shortening of the distance from the engine room to the office. Walter N. Polakov read a paper on a two-rate wage, which proposes a living wage for every worker, irrespective of his efficiency, and an additional wage proportioned to the service rendered. Mr. Polakov stated that the power plant, in which efficiency of service is easy of determination, offers excellent opportunity for the application of such a theory.

Wednesday afternoon was given over to a program of sports at Camden Park.

Thursday, a resolution was made and adopted calling for a joint committee of the N. A. S. E. and the Exhibitors' Association to consider the next meeting place. A resolution providing for junior members is to be submitted to referendum.

There was much discussion regarding getting back ex-members and increasing of the membership. Mr. Cook, president of the Canadian Association of Stationary Engineers, returned the official visit of Secretary Raven, and briefly addressed the meeting.

The following papers were read during the afternoon: "Power Plant Costs," by J. J. McGowan; "Relations of Consulting and Operating Engineers," by Charles A. Cahill, followed by a topical discussion on the details of operating routine in power plants.

The award of flags to associations showed marked gain in membership, Detroit No. 7 receiving first place with 58 new members. A reception followed by the ladies' auxiliary, speeches being made by Mesdames Mullin and Amer. One hundred dollars was voted for the auxiliary and three hundred dollars additional to the salary of the treasurer of the Association.

Thursday evening, entertainment was provided by the Exhibitors' Association.

The Exhibitors' Association elected the following new officers: Horace A. Smith, Philadelphia Grease Co., president; F. N. Chapman, A. Leschen & Sons Rope Co., vice president; A. W. France, France Metallic Packing Co., treasurer; Frank Martin, Jenkins Brothers; Hudson Dickerman, John S. Pratt Co.; W. M. Rand, Ashton Valve Co.; W. L. Schaeffer, National Tube Co., and Chas. McDonald, Allis-Chalmers Co., members Executive Committee.

The national officers for the ensuing year were elected on Friday and are as follows: President, John J. Calahan, Jersey City, N. J.; vice president, Alfred Johnson, Chicago, Ill.; secretary, F. W. Raven, Chicago, Ill.; treasurer, Samuel B. Forse, Pittsburgh, Penn.; conductor, Eugene L. Kissel, Portland, Ore.; chairman board of trustees, H. J. Mistele, Milwaukee, Wis.

The next convention will be held in Milwaukee, Wis.

Coal Meter for Chain-Grate Stokers

To determine the amount of coal consumed by an individual boiler is a comparatively simple matter, but with a battery of boilers, fuel delivered irregularly, and with a large quantity always in stock, it is difficult to ascertain with accuracy how much coal has been consumed per day, or week, unless weighing machines or measuring appliances are provided. The Lea Recorder Co., Ltd., 28 Deansgate, Manchester, says *The Engineer*, has placed on the market an appliance specially intended for boilers fitted with chain grates, which works much upon the same lines as the well-known V-notch recorders and integrators for water measurement. Its action is based on the theory that when coal is supplied to a boiler by means of a chain-grate stoker the amount of fuel passing under the fire-door may be regarded as a stream with a constant width, but the depth and velocity of the stream are subject to variation. The width of the stream is the width of the chain grate, the depth is the thickness of the fire, and the speed is the rate of travel of the chain grate. Therefore: If W = the width of the stream in feet, T the thickness or depth in feet, and V the velocity of the stream in feet, per hour, then,

$$\textit{cubic feet per hour} = W \times T \times V = \textit{cross-sectional area} \times V$$

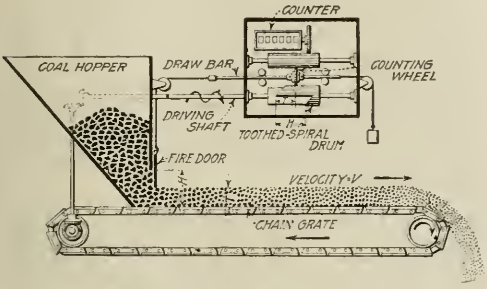


FIG. 1. SHOWING ARRANGEMENT OF COAL METER FOR BOILER FURNACE

Although slack and small coal are not perfectly homogeneous and do not obey the laws of fluids or mathematics exactly, it has been found by experience that under ordinary conditions of working the flow of coal under a fire-door is, generally speaking, proportional to the thickness of the fire and to the velocity of the grate, and that the results are consistent with what might be expected, theoretically. As the width W is constant, and T and V are the only variables, all that is required is some form of automatic integrating mechanism which will at all times take into account the two items T and V, and this is what the inventors claim that the Lea recorder actually does. As will be seen from the diagram, Fig. 1, the motion of the grate is transmitted by gearing to a spirally toothed drum, Fig. 2, the pitch of the teeth of which is equal, or proportionate to, the maximum lift of the fire-door, or the thickness of the fire H, Fig. 1. A toothed counting wheel, Fig. 2, gearing with the spiral drum below, and with a counting box above, is mounted on a rod, or drawbar, directly connected with the fire-door, and as the latter is opened or closed, the counting wheel is moved to and fro laterally across the spiral drum, which causes the wheel to revolve, more or less, according to its lateral position. Assuming, for instance, an 8-in. fire to be the maximum, with that thickness of fuel the counting wheel will engage with all the teeth of the drum; with a 4-in. fire the counting wheel will only engage with a half of them, and if the fire-door is shut the counting wheel and drum will not engage. Therefore, it is claimed that for all variations in the thickness of the fire or in the speed of the grate, the number of revolutions of the wheel will be proportional to the total cubic feet of coal that is passed; and by means of proper constants for the units shown on the counting dials, the total quantity either in cubic feet, tons, or pounds can be determined pretty closely.

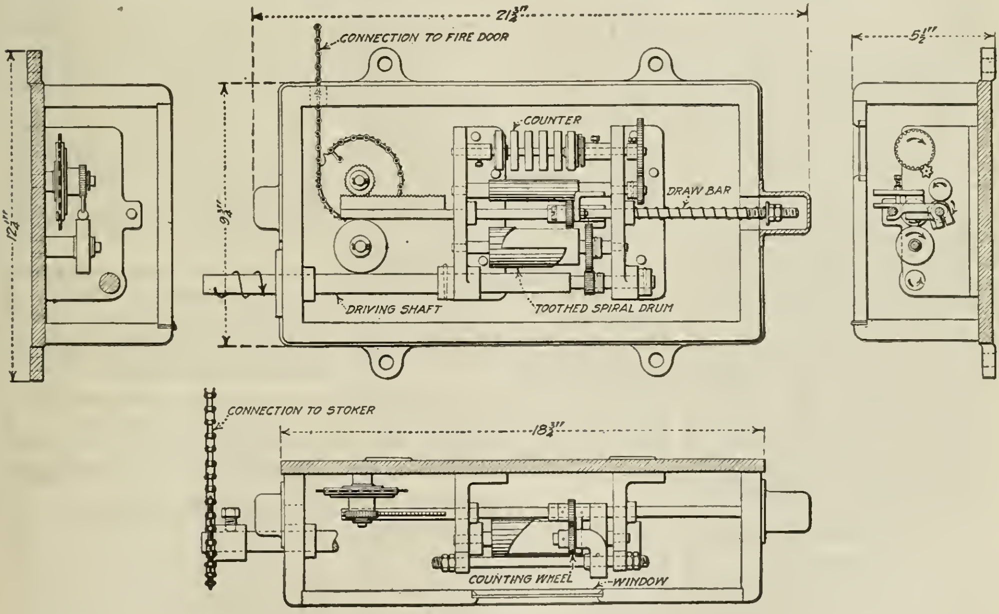


FIG. 2. RECORDING MECHANISM OF FURNACE COAL METER

The determination of the unit used can be done readily by measuring out upon the boiler-room floor a certain number of cubic feet of coal, passing it through the stoker and noting the number of units recorded by the meter. In this connection it is frequently supposed that there are great differences in the weights of small coals for given cubic capacity, on account of the variation in the size of the fuel. This is not borne out either by experience or mathematically. The weights of equal volumes of spherical bodies of different diameters, but of the same specific gravity, are all exactly the same. The percentage of interstices is quite independent of the diameters of the individual spheres, provided, of course, that the size of the containing vessel is reasonably large as compared with that of the material itself. In other words, a cartload of "nuts" of uniform grade weighs approximately the same as a similar load of pea coal.

The mechanism is all inclosed and the apparatus occupies very little space, and need not of necessity be attached to the boiler itslf. It is easily read, requires no skilled attention, and the wearing parts are few. The makers give a guarantee of accuracy to within 5 per cent.

A cylinder rate table for internal-combustion engines has been prepared for use in connection with writing-machinery breakage insurance. This table will be part of the new Steam Boiler and Engine Manual, no previous rates of this kind having been promulgated. The internal-combustion engine table gives the three-year rates for a policy bearing the standard internal-combustion-engine indorsement which must specifically exclude liability for the replacement or renewal of ignition tubes, spark plugs or other igniting apparatus, vaporizers and rubber parts of gas bags. For oil engines of the Diesel type the cylinder rates shall be double the rates shown in the table for the corresponding diameters. To determine the rates for a double-acting internal-combustion engine of any type, assume a single-acting engine of the same type but twice the number of cylinders; then compute the rate in the regular way for the assumed engine.—*Eastern Underwriter.*

During the war an Italian engineer named Adolfo Pouchain, after a series of experiments, succeeded in producing a new alloy of zinc and copper which has been given the name of "Biakmetal." Its most important characteristics are stated as follows: (1) The highest known breaking point; (2) the highest limit of elasticity; (3) perfect homogeneity; (4) high resistance to thermic action and (5) high resistance to chemical action. It is said to be extremely well adapted for almost any kind of manipulation. It can be successfully cast, turned, drawn, rolled, forged and stamped. In its different forms it can be substituted for steel, brass and aluminum.—*Commerce Report.*

Flywheel-insurance rate factors have been revised downward, it having been decided that the present rates are too high on renewals. This revision makes a reduction of much over 100 per cent. on the smaller sizes and up to the neighborhood of $50,000 insurance on a single accident. Above that figure the rates have been materially increased, the advances reaching 100 per cent. in some cases. As there are few coverages over $50,000, the increases in rate factor will not materially affect much of the business, but the ordinary risk will benefit by substantial reductions.—*Eastern Underwriter.*

There are 200 engineering societies in the United States with a total membership of 100,000, the annual dues amounting to about $1,000,000. There are possibly 200 other societies more or less connected with engineering and having many engineers as members. Probably 100,000 other engineers do not belong to any society.—*Compressed Air Magazine.*

Peanuts are said to contain from 38 to 50 per cent. of oil, and pods 4 to 5 per cent. This oil can be successfully burned in Diesel engines, and it may prove a valuable source of fuel in localities where petroleum oils are scarce, such as in the interiors of tropical and semi-tropical countries.—*The Gas Engine.*

During the daylight saving season last year, the Edison Electric Illuminating Co., of Boston, saved 4420 long tons of coal. The decrease in kilowatt-hours from this cause was 5,000,000, representing a loss in revenue of about $350,000.—*Compressed Air Magazine.*

New Publications

TESTS OF WIRE ROPE

Bulletin No. 121, issued by the Bureau of Standards of the Department of Commerce gives a digest of the result of tests of 275 wire ropes submitted by American manufacturers to fulfill the specifications of the Isthmian Canal Commission. The ropes, which were selected by Government officials, were from ½-in. to 1½-in. in diameter, a few being of larger diameters up to 3¾-in. Over half the specimens were plow and crucible cast-steel hoisting rope of 8 strands of 19 wires each, the remainder being guy and tiller ropes of 6 strands of 7 wires and 6 strands of 42 wires each. Tables of results are given, illustrating the tensile strength of specimens of different diameters. The results of tests of the quality of material used, torsion and bending tests of wires and the cumulative elongations, and reductions in diameters of cables are shown. This bulletin is now ready for publication, and those interested may obtain a copy by addressing a request to the Bureau.

Personals

G. T. Hungerford, formerly New York City sales manager of the Files Engineering Co., Inc., Providence, R. I., is now general sales manager.

The Maoternach Co., Hartford, Conn., has opened an office in the Morgan Building, Buffalo, with Walter A. Allen, secretary of the company, in charge.

Fred Gelbauer has been appointed special Navy Yard representative of the Chicago Pneumatic Tool Co., with headquarters at the company's Philadelphia office at 1740 Market St.

D. J. Kerr, electrical engineer at the Champion Fibre Co.'s Canton (N. C.) plant, has been made superintendent of the power department in connection with the electrical department.

Cedric B. Smith has been appointed editor of "The Monad," the official organ of the American Association of Engineers. Mr. Smith was until recently in the employ of the Pennsylvania lines in Pittsburgh.

J. J. Brown, formerly vice president and general manager of the Wheeler Condenser and Engineering Co., Carteret, N. J., was recently elected president of the company to succeed Charles W. Wheeler, deceased.

A. A. Schneider, formerly with the raw materials department of the Midvale Steel and Ordnance Co. and Cambria Steel Co., has been appointed manager of the newly created raw materials division of the American Steel Export Co.

Col. Peter Junkersfeld, who, upon returning to civilian work early this year, resigned as assistant to the vice president of the Commonwealth Edison Co. to become engineering manager of Stone & Webster, has been awarded the distinguished service medal for his work during the war.

P. K. Condict, vice president of the International Western Electric Co., has been awarded the fourth order of merit with the Rising Sun through the Japanese Minister of Communications. This honor has been conferred upon Mr. Condict for services rendered in supplying materials necessary for the extension of the telephone system of Japan.

Wiliam G. R. Braemer, formerly president of the Braemer Air Conditioning Corp., has resigned to engage in active professional practice as a consulting engineer, with offices in the Stephen Girard Building, Philadelphia. Mr. Braemer was for many years chief heating and ventilating engineer for the Buffalo Forge Co., of Buffalo, N. Y., and later was official advisor and assistant of Warren Webster & Co., Camden, N. J.

L. E. Strothman, who for several years has been manager of the steam turbine and pumping engine departments of the Allis-Chalmers Manufacturing Co., and prior to that was connected with the Filer & Stowell Co. and the Nordberg Manufacturing Co., has resigned to become vice president and general manager of the Richardson-Phenix Co. Mr. Strothman is well known in manufacturing circles as well as in the various professional engineering societies. In making the change J. Wm. Peterson has become president and treasurer of the Richardson-Phenix Co.

Engineering Affairs

The New England Section, N. E. L. A., will hold its anual convention in New London, Conn., Sept. 22-24, and not Sept. 16-18, as reported in last week's issue.

Miscellaneous News

The Empire State Gas and Electric Association will hold a meeting in Buffalo Oct. 24.

An Electrical Show will be held in Buffalo from Oct. 16-25. This will be the first electrical show held in that city since March, 1914.

The American Boiler Manufacturers' Association will hold a meeting at the Hotel Astor, New York City, Sept. 24. The subject of "Boiler Costs' will be discussed.

The Joint Commission on Reclassification of Salaries, created by the Sixty-fifth Congress, instructed to investigate the rates of compensation paid to civilian employees by the municipal government and other government establishments in the District of Columbia, is engaged in making a preliminary classification. The Washington Chapter of the American Association of Engineers is securing information relative to the salries of technical men included within the scope of the investigation the commission is authorized to make, and making recommendations as to the revisions which should be made. The actual preparation of the commission's report is being made by Arthur Young & Co., efficiency engineers.

Business Items

The Goulds Manufacturing Co., Seneca Falls, N. Y., will open a district sales office in the Dime Bank Building, Detroit, Mich., on Sept. 1, with E. B. Gould in charge.

The Dickey Steel Co., Inc., Woolworth Building, New York City, has been appointed sales representative for the New York and Philadelphia district of the Worcester Pressed Steel Co., of Worcester, Mass., manufacturer of hot and cold rolled strip steel, and light and heavy metal stampings.

Trade Catalogs

The L. J. Wing Manufacturing Co., New York City, has issued a 16-page bulletin No. 58, which illustrates and gives some useful general information on "Scruplex Fans and Exhausters."

The **Wellman-Seaver-Morgan Co.,** Cleveland, Ohio, has issued bulletin No. 27, which describes and illustrates W-S-M automatic ore unloaders on the Great Lakes. A copy of the bulletin may be had free upon request.

S. F. Bowser & Co., Inc., Fort Wayne, Ind., has issued a little folder which illustrates and describes a Bowser battery storage system for lubricating oil. It shows how tanks of varying capacity may be placed in battery, all of uniform height.

The Worthington Pump and Machinery Corp. has acquired the entire plant and other properties of the Epping-Carpenter Pump Co., of Pittsburgh, Penn., to which all correspondence should hereafter be addressed.

The Mesta Machine Co., Pittsburgh, Penn., has published Bulletin S, containing 32 pages on "Mesta Auxillary Equipment for Rolling Mills," illustrating and describing the most modern machinery for rolling mills. Copies of the bulletin will be sent free upon request.

The Weber Chimney Co., Chicago, Ill., has issued a new 54-page catalog, No. 19, on "Weber Chimneys," which illustrates and fully describes these chimneys, method of construction, etc., including that of the highest chimney in the world, built in Japan. Copy may be had free upon request.

The Fisher Governor Co., Inc., Marshalltown, Iowa, has issued a 94-page catalog, T-19, on "Fisher Steam Traps," type No. 33. It is a very complete, detailed and comprehensive trap catalog, and the illustrations alone convey an excellent idea of the merits of this trap. Some suggestive illustrations are shown on the last few pages.

The Diamond Power Specialty Co., Detroit, Mich., has issued its 24-page bulletin No. 132, entitled "Profits That Get Away Through Your Boiler Room." It deals with the importance of exercising business-like supervision over the boiler room; the effect of soot on boiler efficiency and also describes Diamond soot blowers for horizontal return tubular boilers. Copy free upon request.

The Allis-Chalmers Manufacturing Co. announces a new line of commutating pole direct-current motors and generators designated as Type E. The machines are rugged and compact and have excellent operating characteristics. The many details which contribute to accessibility, reliability and safety have been thoroughly worked out. This line includes the following standard ratings: 1, continuous rated (50 deg. C. rise) motors, for applications where the power requirements are definitely known; 2, normal rapid (40 deg. C. rise) general purpose motors; 3, adjustable speed motors for continuous or intermittent service; 4, generators and exciters. For constant speed motors the ratings and speeds are the same as those of 60-cycle induction motors, and they can thus be used interchangeably with induction motors for direct connected applications without changing the method of drive or the ratio of gearing. Adjustable speed motors, intended particularly for machine tool and similar applications are provided for 2:1 or 4:1 speed range. Generator speeds also correspond to those of induction motors, thus permitting the direct coupling of the machines to form motor-generator sets in various combinations. The line of ratings now complete covers motors from ½ to 50 hp. and generators from ½ to 40 kw., while larger sizes are under development. These machines are described in Bulletin No. 1106.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F. o. b. mines, net tons	$2.60@3.00	$3.00@3.50
F. o. b. Philadelphia, gross tons	4.79@5.25	5.20@5.70
F. o. b. New York, gross tons	5.10@5.60	5.50@6.00
Alongside Boston (water coal), gross tons	6.85@7.85	7.10@7.85

Georges Creek is quoted at $3.70 per net ton, f. o. b. mines.

Pocahontas and New River are being quoted at $6.00@6.50 per gross ton f.o.b. Norfolk and Newport News, Va., in response to export demand. There are practically no sales for coastwise shipment.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5.95	$7.80	Pea	$5.30	$7.05
Egg	6.35	8.20	Buckwheat	3.40	5.15
Stove	6.60	8.45	Rice	2.75	4.50
Chestnut	6.70	8.55	Barley	2.25	4.00

Bituminous

Current quotations on spot coal, net tons, at the mines average about as follows:

	Spot
South Fork (best)	$3.25@3.50
Cambria (best)	3.00@3.25
Cambria (ordinary)	2.70@2.90
Clearfield (best)	3.00@3.25
Clearfield (ordinary)	2.70@2.90
Reynoldsville	2.70@2.90
Quemahoning	3.25@3.50
Somerset (medium)	3.10@3.25
Somerset (poor)	2.65@2.75
Western Maryland	2.65@2.75
Fairmont	2.50@2.65
Latrobe	2.75@2.90
Greensburg	2.75@3.00
Westmoreland ¾ in.	3.50@3.75
Westmoreland run-of-mine	3.20@3.35

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide		Anthracite Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	6.35	8.20	Rice	2.75	3.65
Stove	6.60	8.45	Boiler	2.50	3.50
Nut	6.70	8.55	Barley	2.25	3.15
Pea	5.30	6.90			

PITTSBURGH—Counting out occasional low and high priced sales involving but small tonnage, the great bulk of the transactions is quotable as follows, Pittsburgh District:

Steam:	Per Net Ton
Slack	$2.10@2.30
Mine-run	2.50@2.60
Gas:	
Slack	2.20@2.40
Mine-run	2.50@2.70
Prepared sizes	2.60@2.90

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.25	$2.60	$2.40
Black Creek and Cahaba	3.25	3.45	3.05
Jagger - Pratt Corona	2.85	3.00	2.45
Blacksmith	....	5.25	.....

Domestic quotations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	5.00@$5.50
Corona	3.50
Jagger	3.50
Montvallo	5.50@$6.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

	Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$3.25	$2.55	$2.75
Mine run	2.40*@2.60	2.35	2.00@2.20
Screenings	2.10*@2.30	2.05	2.00

* Indicates prices on independent coal.

Williamson-Franklin rate to St. Louis is $1.07½; other rates $0.92½.

New Construction

PROPOSED WORK

Conn., Bridgeport—Fletcher-Thompson, Inc., Engr., 1089 Broad St., will receive bids about September 20 for the construction of a 7 story, 100 x 140 ft. cold storage building on Seaview Ave., for the Peoples Ice & Cold Storage Co., 1335 Seaview Ave.

N. Y., Corona—The Sheer's Amusement Co. will build a 1 story theatre on Continental and Queens Blvds. A steam heating system will be installed in same. Total estimated cost, $100,000. Work will be done by day labor.

N. Y., Long Island City—The Lehigh Silk Hosiery Co., 220 5th Ave., New York City, will soon award the contract for the construction of a 7 story factory here. A steam heating system will be installed in same. Total estimated cost, $1,000,000. Ballinger & Perrott, 47 West 34th St., New York City, Engr. and Arch.

N. Y., New Rochelle—D. W. Griffith, 1476 Broadway, New York City, will build a 1 story, 150 x 200 ft. studio here. A steam heating system will be installed in same. Total estimated cost, $500,000. Work will be done by day labor, under supervision of Russel B. Smith, Engr., 50 East 42nd St., New York City.

N. Y., New York—The Board of Education, 500 Park Ave., is having plans prepared for the construction of a 5 story, 59 x 112 ft. school at 201-207 Hester St. A steam heating system will be installed in same. Total estimated cost, $375,000. C. B. J. Snyder, Municipal Bldg., Engr.

N. Y., Walton—The J. Kayser Co., 32nd St. and Madison Ave., New York City, is having plans prepared for the construction of a 1 story factory, here. A steam heating system will be installed in same. Total estimated cost, $100,000. William Higginson, 18 East 41st St., New York City, Engr. and Arch.

N. J., Union—The Board of Education will receive bids September 18, for the installation of heating and ventilating systems in new school here. G. J. Bieling, Pres.

N. J., Union Hill—The Board of Education will soon award the contract for furnishing and installing heating and ventilating systems, plumbing, vacuum cleaner, etc., in the proposed new school building on 1st St. and Hudson Ave. Total estimated cost, $250,000. Noted Feb. 18.

Pa., Bath—The Pennsylvania Cement Co. plans to install power plant and waste heat boiler, at their mill here. The Republic Engineers, Inc., 60 Broadway, New York City, Engr.

Pa., Chester—Nixon & Nirdlinger, 16th and Walnut Sts., are having plans prepared by H. C. Hodgens, Arch., 130 South 15th St., for the construction of a 1 story, 150 x 180 ft. theatre and store building. A steam heating system will be installed in same. Total estimated cost, $100,000.

Pa., New Brighton—The Board of Education is receiving bids for the construction of a 3 story, 91 x 135 ft. and a 2 story, 82 x 98 ft. high school, on Pierce and East 4th Sts. Hot air system with fan will be installed in same. W. G. Eckles, New Castle, Arch.

Fla., New Port Richey—The city plans to install an electric light and ice making plants.

Ohio, Greenville—The town voted $45,000 bonds to build waterworks and electric light plant.

Mich., Detroit—The Board of Education, 50 Broadway, received bids for the installation of heating, ventilating and plumbing systems in proposed Nichols School, on Burns and Goethe Ave from M. B. O'Connor, Penobscot Bldg., $42,025; R. L. Stitzler Heating Co., 403 Vinton Bldg., $51,777; A. W. Schultze Co., 815 Gratiot Ave., $54,605; in proposed Ellis school, from A. W. Schultze & Co., 403 Vinton Bldg., $36,927, and in proposed Condon School on Buchanan and Vinewood Ave., from M. B. O'Connor, Penobscot Bldg., $48,996; A. W. Schultze Co., 815 Gratiot Ave., $58,608. Noted Aug. 26.

Mich., Detroit—The Detroit Edison Co., David Whitney Bldg., has had plans prepared for the construction of a 2 story, 25 x 113 ft. electric sub-station, at Connor's Creek, near Six Mile Rd. Estimated cost, $40,000.

Mich., Detroit—The Michigan Machine Co., 16th and Porter St., is having plans prepared for the construction of a 3 story, 107 x 158 ft. factory. Steam heating system and electric motors for power, will be installed in same. Total estimated cost, $150,000. Brown & Preston, 406-8 Empire Bldg., Arch.

Mich., Grand Rapids—The Grand Rapids Tuberculosis Hospital is having plans prepared for the construction of a 4 story, 50 x 170 ft. main building, 2 story, 50 x 100 ft. nurses home, and a 70 x 70 ft. power plant to include 2 steam units each 300 hp. Total estimated cost, $400,000. Robinson & Campau, Grand Rapids, Arch.

Mich., Jackson—W. W. Bradfield, Engr., and H. L Mead, Arch., both of Grand Rapids, are receiving bids for the construction of a 5 story, 123 x 265 ft. factory here, for the Michigan Seating Co., East Washington St. Steam heating and power equipment will be installed in same.

Mich., Saginaw—Cooper & Beckbissinger, Arch , 114 South Jefferson St., arc preparing plans for the construction of a 4 story, 100 x 120 ft. factory here. Steam heating equipment will be installed in same. Owner's name withheld.

Ill., Chicago—Wilson Jones Loose Leaf, 3021 Carroll Ave., will soon award the contract for the construction of a 2 story, 250 x 400 ft. stationers' supply factory on Ohio St. and Spaulding Ave. A steam heating system will be installed in same. Total estimated cost, $400,000. L. G. Hallberg & Co., 116 South Michigan St., Arch. Noted Aug. 26.

Ill., Waterloo—The Waterloo Condensed Milk Co. wants a refrigerating apparatus and one or two boilers.

Minn., Hibbing—The city will soon award the contract for the construction of a 2 story, 135 x 251 ft. recreation building on 1st Ave. and Jackson St. A steam heating system will be installed in same. Total estimated cost, $350,000. Holstead & Sullivan, Palladio Bldg., Duluth, Engr. and Arch.

Minn., Rochester—A. Fawcett, Rochester, will receive bids until September 20, for the construction of a 5 story, 46 x 142 ft. dental building. Steam heating and electric light system will be installed in same. Total estimated cost, $300,000. F. M. Mann, Metropolitan Life Bldg., Minneapolis, Arch.

Kan., Oswego—The city will soon award the contracts for furnishing and erecting the following equipment: 1 internal combustion engine of 200 hp. capacity, direct connected to a 150 K.V.A. generator; 1 internal combustion engine of 150 hp. capacity direct connected to 125 K.V.A. generator; exciters complete for generators; 1 four panel switch board erected complete; air tanks, air starters, gasoline tanks, and all piping for engine to be furnished and installed; furnishing all foundations for machines under another contract; furnishing all material and wiring power house and making all electric connections from generator and switchboard. Noted February 4.

Mo., St. Louis—The Blackwell Wielandy Stationery Co., 16th and Locust St., will soon award the contract for the construction of a 7 story, 90 x 150 ft. mercantile building. Heating and sprinkling equipment will be installed in same. Total estimated cost, $350,000.

Mo., St. Louis—Herman Kaupe, 3009 McNair Ave., is in the market for a 14 h.p. alternating current motor.

Mo., St. Louis—The Pan-Electric Manufacturing Co., 735 South 4th St., is in the market for a 75 to 100 h.p. boiler.

Tex., Fort Worth—The Ok-in Producing & Refining Co. will soon receive bids for steel tankage and water tube boilers in connection with the proposed refinery.

Okla., Nowata—The city is having plans prepared by Burns & McDonald, Engr., Interstate Bldg., Kansas City, Mo., for waterworks and electric light improvements.

Okla., Ponca City—The city voted $50,000 bonds to build electric light plant.

Okla., Sapulpa—The Southern Ice & Utilities Co. plans to build a 2 story, 50 x 150 ft. cold storage plant, on Main St. Estimated cost, $25,000.

Wash., Seattle—J. D. Hull, Coleman Bldg., is in the market for a generator set.

Ariz., Chandler—The Trustees of Chandler School District will soon receive bids for the construction of a 2 story high school. A plenum heating and ventilating system will be installed in same. Total estimated cost, $125 000. Allison & Allison, Hibernian Bldg., Los Angeles, Cal., Arch.

Ont., London—The Utilities Commissioners, Hydro Offices, will soon award the contract for the erection of a substation and installation of transformers. Total estimated cost, $10,000. E. V. Buchanan, Hydro Offices, Engr.

Ont., Toronto—The Canadian General Electric Co , King and Simcoe Sts., plans to construct a 6 story, 50 x 200 ft. storehouse and office building, on King St. W. A vacuum steam heating system will be installed in same. Total estimated cost, $200,000.

CONTRACTS AWARDED

Mass., Lowell—The Standard Oil Co., 26 Broadway, New York City, has awarded the contract for the construction of a 1 story, garage and a 1 story warehouse on Main & Canada St. here, to H .D. Best, 949 Broadway, New York City. A steam heating system will be installed in same. Total estimated cost, $100,000.

N. Y., Bronx—The Board of Education, 500 Park Ave., New York City, has awarded the contract for the installation of a heating and ventilating apparatus in P. S. No. 57, Crotona and Belmont Ave , to E. Reutzler Co., 404 East 49th St., New York City, $115,712. Noted Sept. 9.

N. Y., S. I., Doogan Hills—The Board of Education, 500 Park Ave., New York City, has awarded the contract for the construction of P. S No. 11, Jefferson Ave. between Cromwell and Carretson Ave., to J. MacArthur, 120 Broadway, New York City. A steam heating system will be installed in same. Total estimated cost, $180,000.

Pa., Philadelphia—The Hale & Kilburn Corporation, 18th and Lehigh St., has awarded the contract for the construction of a 5 story, 196 x 260 ft. factory, on 16th and Glenwood Sts., to H. E. Baton, 1713 Sansom St A steam heating system will be installed in same. Total estimated cost, $100,000.

Pa., Williamsport—The Board of Education has awarded the contract for installing a steam heating system in connection with the proposed 3 story, 100 x 120 ft. school building on Wayne Ave., to F. Keeler Co., 238 West St., Williamsport, $49,534.

N. C., Nashville—Nash County has awarded the contract for heating and plumbing in the proposed new courthouse here, to W. W. Dick, Greenboro. Estimated cost, $15,000.

Ohio, Cleveland—The Colburn Machine Tool Co., 1041 Ivanhoe Road, has awarded the contract for the construction of a 1 story, 192 x 238 ft. factory, at 1040 Ivanhoe Road, to the Honkin Conkey Co., Century Bldg., Cleveland. A steam heating system will be installed in same. Total estimated cost, $100,000.

Mich., Flint—The General Motors Corporation, 435 Woodward Ave., Detroit, has awarded the contract for the construction of a 7 story, 214 x 280 ft. recreation building here, to Thompson-Starrett Co., Lincoln Bldg., Detroit. Steam heating equipment will be installed in same. Total estimated cost, $2,300,000.

Mich., Pontiac—The General Motors Truck Co. has awarded the contract for the construction of 3 story, 80 x 300 ft. warehouse, to W. E. Wood & Co., Ford Bldg., Detroit. Steam heating apparatus and freight elevators will be installed in same. Total estimated cost, $100,000.

Wis., Sheboygan—The Bemis Riddel Co., South Water St., has awarded the contract for the construction of a factory, to the Prange Guessenhainer Co., North 8th St. A steam heating system will be installed in same. Total estimated cost, $11,900.

Kan., Wichita—The Board of Education has awarded the contract for the installation of heating and plumbing systems in Mark Twain school, 3 story, 103 x 182 ft., to the McMahon Heating & Plumbing Co., Kansas City, Mo. Estimated cost, $41,500

Ore., Portland—The Oregon Casket Co., 101 North 5th St., has awarded the contract for the construction of a 2 story factory on 21st and Raleigh St., to the Dinwiddie Construction Co., Yeon Bldg Plans include 4 dry kilns, boiler house and shed. First unit will cost $175,000, ultimate cost, $350,000.

Cal., Los Angeles—The Board of Public Works has awarded the contract for the construction of a concrete sewage pumping pit, on Manchester Ave., to John F. Blee, 501 Stimson Bldg. Estimated cost, $12,000. Noted Aug. 26.

Cal., Torrance—The Southern California Edison Co , Edison Bldg., Los Angeles, has awarded the contract for the construction of a 3 story, 54 x 142 ft. sub-station, to K. R Bradley, 1925 East 16th St., Los Angeles. Estimated cost, $60,000

Ont., Brantford—The Slingsky Manufacturing Co., Ltd. 270 West Mill St., has awarded the contract for the 3 story, 60 x 100 ft. addition to mill, and new 4 story, 50 x 80 ft. dye house, to P. H. Secord & Son, 133 Nelson St A steam vacuum system will be installed in same. Total estimated cost, $200,000.

Ont., Hamilton—The Board of Education has awarded the contract for the construction of a 2 story school, to W. H. Cooper, Clyde Bldg. Steam heating system with fan ventilation will be installed in same. Total estimated cost, $100,000.

Ont., Toronto—Loew's Theatre Syndicate, 1942 Broadway, New York City, has awarded the contract for the construction of a 2 story, 140 x 225 ft. vaudeville theatre, on Yonge St , here, to P. H. Secord & Son, 133 Nelson St., Brantford. An oil heating system will be installed in same. Total estimated cost, $300,000.

Ont., Toronto—The Panlages Theatres Ltd , Adelaide St., has awarded the contract for the construction of a 2 story, vaudeville theatre, on Victoria St., to Jackson Lewis & Sons, Bell Telephone Bldg. An oil heating system will be installed in same. Total estimated cost, $600,000.

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PRICES-MATERIALS-SUPPLIES

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE—

Fire	50-Ft. Lengths
Underwriters' 2½-in	75c. per ft.
Common, 2½-in	40%

Air	First Grade	Second Grade	Third Grade
¾-in. per ft	$0 50	$0 33	$0 22

Steam—Discounts from List

First grade	30%	Second grade	40%	Third grade	45%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	65%	Best grade	35%
Standard	50%		

Note—Above discounts apply on new list issued July 1.

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	45%	35%
St. Louis	40%	30%
Chicago	45%	40%
Birmingham	35%	30%
Denver	35-5%	30%

RAWHIDE LACING—20% for cut; 45c. per sq. ft. for ordinary.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0 90
Asbestos for high-pressure steam	1 50
Duck and rubber for piston packing	1 00
Flax, regular	1 20
Flax, waterproofed	1 60
Compressed asbestos sheet	90
Wire insertion asbestos sheet	1 10
Rubber sheet	50
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1 20
Asbestos wick, ½- and 1-lb balls	85

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0 27	½-in.	$0 27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	60	2 -in.	60
3-in.	45	2½-in.	75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure		List
For low-pressure heating and return lines	4-ply	58% off
	3-ply	60% off
	2-ply	62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Pittsburgh	Chicago	St. Louis	Birmingham	Denver
Cup	7	9	5¼	6.7	8½	14½
Fiber or sponge	8	10	6	13	9	18
Transmission	7	9	6	13	7½	17
Axle	4½	6	4	4 75	3-4	5¼
Gear	4½	9	4½	7.5	5½	8
Car journal	22(gal.)	21 (gal.)	3½	4 7	6¾	8

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Current	One Year Ago		
White	13.00	11 00 to 13 00	14 00	11 00 to 14.00
Colored mixed	9.00 to 12.00	8.50 to 12 00	11 00	9 50 to 12.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13½ x 13½	13¾ x 20½
Cleveland	$52 00	$58 00
Chicago	41 00	43 50

LINSEED OIL—These prices are per gallon:

	New York		Cleveland	Chicago	
	Current	One Year Ago	Current	Current	One Year Ago
Raw in barrels (5 bbl. lots)	$2.15	$1.86	$2.50	$2.48	$1 97
5-gal. cans	2.28	1.96	2.75	2.68	2.17

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	13 00	14 50	14 00	14 50	13 00	14 00
25- and 50-lb. kegs	13 25	14 75	14 25	12 75	13 25	14 25
12½-lb. keg	13 50	15 00	14 50	15 00	13.50	14 50
1-lb. cans	16 00	17.50	....	.....	16 00	17 00
5-lb. cans	15 00	16 50	....	.....	15.00	16 00

00 lb. lots less 10% discount; 2000 lb. lots less 10-2½%.

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel 7/16 and smaller	50-10%	60%	55%
Tinned	50-10%	60%	55%

Boiler rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York	$4 72	Cleveland	$4.00	Chicago	$4.87	Pittsburgh	$4 20

Structural rivets, same sizes:

New York	$4 82	Cleveland	$4.10	Chicago	$4.97	Pittsburgh	$4 30

REFRACTORIES—Following prices are f. o. b. works, Pittsburgh:

Chrome brick	net ton	$80-90	at Chester, Penn.
Chrome cement	net ton	45-50	at Chester, Penn.
Clay brick, 1st quality fireclay	net ton	35-45	at Clearfield, Penn
Clay brick, 2nd quality	net ton	30-35	at Clearfield, Penn.
Magnesite, dead burned	net ton	32.50	at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-90	at Chester, Penn.
Silica brick	net ton	41-45	at Mt. Union, Penn.

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—Fire Clay, $35 to $50.
Birmingham—Silica, $48; fire clay, $42; magnesite, $85; chrome, $85.
Chicago—Second quality, $25 per ton.
Denver—Fire clay, $11 per ton.

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	90 00	125 00	80 00	108 00	60.00	100 00
Commercial	50 00	70 00	18 50	23 00	13 00	24 00

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$21-26	$19 00
Cleveland	20 00	20 00
Chicago	16.50	19 00

In coils an advance of 50c. usually is charged.
Domestic iron (Swedish analysis) is selling at 15c. per lb.

POLES—Prices on Western red cedar poles:

	New York	Chicago	Denver	San Francisco
6 in. by 30 ft	$5.82	$5.17	$4.55	$5.17
7 in. by 30 ft	7 65	6 85	6.10	6.85
7 in. by 35 ft	11.10	10 00	8.95	10 00
8 in. by 35 ft	12.65	11 35	10.10	11 35
7 in. by 40 ft	12.85	11.50	10.20	11.50
8 in. by 45 ft	18 90	16.90	15.00	16.90
8 in. by 50 ft	22.65	20 30	18 00	20.30

10c. higher freight rates on account of double loads.
For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft	$9.00
12-in. butts, 6-in. tops, length 30-40 ft	11 50
12-in. butts, 6-in. tops, length 41-50 ft	12 50
14-in. butts, 6-in. tops, length 51-60 ft	21 00
14-in. butts, 6-in. tops, length 61-71 ft	23.50

PIPE—The following discounts are for carload lots f. o. b. Pittsburgh; basing card of Jan. 1, 1919, for steel pipe and for iron pipe:

BUTT WELD

Inches	Steel Black	Galvanized	Inches	Iron Black	Galvanized
⅛, ¼, and ⅜	50½%	24%	¾ to 1½	39½%	23½%
½	54½%	40%			
¾ to 3	57½%	44%			

LAP WELD

2	50½%	38%	2	32½%	18½%
2½ to 6	53½%	41%	2½ to 6	34½%	21½%

BUTT WELD, EXTRA STRONG PLAIN ENDS

⅛, ¼ and ⅜	46½%	29%	¾ to 1½	39½%	24½%
½	51½%	39%			
¾ to 1½	55½%	43%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	48%	37½%	2	33½%	20½%
2½ to 4	51%	40½%	2¼ to 4	35¼%	23½%
4½ to 6	50%	39½%	4½ to 6	34½%	22½%

Stock discounts in cities named are as follows:

	New York		Cleveland		Chicago	
	Black	Galvanized	Black	Galvanized	Black	Galvanized
¾ to 2 in. steel butt welded	47%	31%	43½%	34½%	57½%	44%
2½ to 3 in. steel lap welded	42%	27%	45½%	30½%	53½%	41%

Malleable fittings. Class B and C, from New York stock sell at list + 12½%
Cast iron, standard sizes, 10-5% off.

BOILER TUBES—The following are the prices for carload lots, f. o. b. Pittsburgh:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in	40½	3½ to 4½ in	15½
2½ to 3¼ in	30½	3 to 3¼ in	1
2¼ in	24	2½ to 2¾ in	+1
1¾ to 2 in	19½	2 to 2¼ in	+16
		1¾ to 1⅞ in.	+29

Standard Commercial Seamless—Cold Drawn or Hot Rolled

	Per Net Ton		Per Net Ton
1 in	$327	1⅞ in	$207
1¼ in	267	2 to 2½ in	177
1½ in	237	2¾ to 3¼ in	167
1¾ in	207	4 in	187
		4½ to 5 in	207

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation

ELECTRICAL SUPPLIES

ARMORED CABLE—

B.&S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$104.00	$138.00	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:

Less than coil lots	Net List
Coils to 1,000 ft	10%
1,000 ft. and over	15%

BATTERIES, DRY—Regular No. 6 size red seal, Columbia, or Ever Ready

	Each, Net
Less than 12	$0.40
12 to 50	.38
50 to 125 (bbl.)	.35
125 (bbl.) or over	.32

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per 100 for couplings and elbows:

	Conduit		Elbows		Couplings	
Size, In	Black 1,000 Ft. and Over	Galvanized 1,000 Ft. and Over	Black 100 and Over	Galvanized 100 and Over	Black 100 and Over	Gavanized 1100 and Over
⅜	$71.15	$76.25	$17.04	$18.18	$5.38	$5.74
½	71.15	76.25	17.04	18.18	6.28	6.70
¾	93.96	100.86	22.43	23.93	8.97	9.57
1	138.39	149.09	33.19	35.41	11.66	12.44
1¼	187.91	201.71	42.62	45.31	16.10	17.12
1½	224.68	241.18	56.82	60.62	19.89	21.15
2	302.29	324.49	104.17	110.77	26.52	28.20
2½	477.95	513.05	170.46	181.26	37.88	40.28
3	625.00	670.91	454.56	483.36	56.82	60.42
3½	779.24	834.44	1,003.82	1,067.42	75.76	80.56
4	945.03	1,010.43	1,160.08	1,233.57	94.70	100.7[illegible]

5% cash 10 days.

From New York Warehouse—Less 5% cash

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.	
7/16	250	$0.05½	Coils.. 55% off Less coils, 45% off
¼	250	.06	
⅜	250	.09	
½	200	.12	
⅝	200	.15	
¾	150	.13	
1	100	.25	
1¼	100	.33	
1½	Odd lengths	.40	
2	Odd lengths	.55	

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S. B	.33
D. P. S. B	.19	T. P. D. B	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B	.42	1.05	
T. P. S. B.	.81	1.80	
D. P. D. B.	.78	2.10	
T. P. D. B	1.35	3.60	
T. P. to D. P. D. B	.90	2.52	

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$16.75
No. 16 cotton twisted	22.00
No. 18 cotton parallel	19.80
No. 16 cotton parallel	25.75
No. 18 cotton reinforced heavy	30.00
No. 16 cotton reinforced heavy	36.50
No. 18 cotton reinforced light	23.40
No. 16 cotton reinforced light	27.50
No. 18 cotton Canvasite cord	26.00
No. 16 cotton Canvasite cord	28.50

FUSES, ENCLOSED—

250-Volt	Std Pkg.	List
3-amp. to 30-amp	100	$0.25
35-amp. to 60-amp	100	.35
65-amp. to 100-amp	50	.90
15-amp. to 200-amp	25	2.00
7-amp. to 400-amp	25	3.60
02-amp. to 600-amp	10	5.50

600-Volt	Std. Pkg.	Lis
3-amp. to 30-amp.	100	.40
35-amp. to 60-amp.	100	.60
65-amp. to 100-amp.	50	1.50
110-amp. to 200-amp.	25	2.50
225-amp. to 400-amp.	25	5.50
450-amp. to 600-amp.	10	8.00

Discount:	
Less 1-5th standard package	30%
1-5th to standard package	40%
Standard package	52%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package	$4.75 C
0-30 ampere, less than standard package	6.00 C

LAMPS—Below are present quotations in less than standard package quantities.

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B— Watts	Plain	Frosted	No. in Package	Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.35	$0.38	100	75	$0.70	$0.75	50
15	.35	.38	100	100	1.10	1.15	24
25	.35	.38	100	150	1.65	1.70	24
40	.35	.38	100	200	2.20	2.27	24
50	.35	.38	100	300	3.25	3.35	24
60	.40	.45	100	400	4.30	4.45	12
100	.85	.92	24	500	4.70	4.85	12
				750	6.50	6.75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list

PLUGS, ATTACHMENT—

		Each
Hubbell, porcelain No. 5406,	standard package 250	$0.24
Hubbell composition No. 5467,	standard package 50	.32
Benjamin swivel No. 903,	standard package 250	.20
Hubbell current taps No. 5638,	standard package 50	.40

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$12.00	$14.00	$13.90	$25.00
12	13.25	15.70	18.05	30.70
10	18.30	21.00	23.85	41.50
8	25.54	28.60	32.70	56.77
6	....	......	51.40	.
4	.. ...	......	70.00	.
2	......	......	101.80	..
1	......	......	131.86	..
0	......	......	160.00	..
00	......	......	193.50	.....
000	.....	......	235.20	.....
0000	....	......	288.60	.....

Prices per 1000 ft. for Rubber-covered Wire in Following Cities:

	Denver			Birmingham		
	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$11.25	$14.00	$31.00	$11.24	$15.39	$27.17
10	21.85	28.25	56.75	21.58	34.73	48.55
8	31.05	38.30	77.95	30.11	58.59	66.49
6	48.80	52.65	.	59.28	82.11	
4	70.00	75.30		84.86	118.86	.
2	104.85	112.45	.	......	155.40	.
1	136.85	146.15	....	......	188.86	.. .
0	......	194.25	....	......	228.90	....
00	. . . .	239.60	....	......	279.30	.....
000	. .	294.00	...	......	338.50	.....
0000	. . .	358.25	...	......	446.75	.....

Pittsburgh—23c. base; discount 50% St. Louis—30c. base.

SOCKETS, BRASS SHELL—

¼ In. or Pendant Cap.			⅜ In. Cap		
Key, Each	Keyless, Each	Pull, Each	Key, Each	Keyless, Each	Pull, Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package	+20%
1-5th to standard package	+10%
Standard package	−15%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B.&S. regular spools (approx. 8 lb.)	36c. lb.
No. 18 B.&S. regular 1-lb. coils	37c. lb.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 50c. lb., 100 lb. lots	48c. lb.
Rubber tape, ¾ in., less 100 lb., 65c. lb., 100 lb. lots	60c. lb.
Wire solder, less 100 lb. 50c. lb., 100 lb. lots	46c. lb
Soldering paste, 2 oz. cans Nokorode	$1.20 doz.

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$0.42	$0.68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole Each
30	.70	1.06	1.60	2 120
60	1.18	1.80	2.70	3.60
100	2.38	3.66	5.50	7 3
200	4.40	6.76	10.14	13.50

Discounts:

Less than $10.00 list value	+ 5%
$10 to $25 list value	— 8%
$25 to $50 list value	—15%
$50 to $200 list value	—20%
$200 list value or over	—25%

POWER

Volume 50 New York, September 23, 1919 *Number* 13

What Are You Doing With Today?

THE Medical Profession has often told us that the normal individual requires at least seven hours of sleep and that the majority would last longer if they "sawed wood" for eight hours. Assuming that for hygienic reasons we spend one-third of our life in bed, how many of us are fully awake the remaining sixteen hours of each twenty-four? It is true one may potter around the plant for eight, ten or twelve hours, as schedule may require, and then are often obliged to spend nights and Sundays there, too.

It is self-evident that the power plant is the heart of the factory or community and that its pulse beat must be uniformly maintained to avoid stopping the wheels of progress. Occasional overtime work for needed repairs or for economy of operation is to be expected and is just as necessary for the engineering profession as for the physician with his night calls or the lawyer with his lawbooks. The important question is not "How much time do we put in," but "How much do we get out of the time we put in?"

There is such a thing as employing our time wisely, usefully and efficiently through the working day in the interest of our employer, as well as during the recreation hours, which belong to us. Time is the one free commodity that is delivered to all in equal quantities without regard to the high cost of living. A fresh supply greets us every morning, and it is ours to dispose of as we see fit or as our circumstances dictate. We can use the fleeting moments as they pass, but we cannot squander the future or recover the past.

How often we think of the things we plan to do some day when we have time, little realizing that we already have had all the time there was and are still receiving our daily quota! How are we going to fulfill those ambitions to rise higher in our profession or occupation, to increase our fund of knowledge, to enlarge our earning value or sphere of influence, to be of greater service to others when we have so little spare time?

Success cannot be obtained without consistent effort and personal inconvenience. It requires a more systematic use of the twenty-four hours we are privileged to enjoy each day. It may necessitate rising half an hour earlier or staying up half an hour later, or of skimming through newspapers instead of perusing in detail the daily scandals and unique advertisements. Or it may mean useful reading on trains or trolleys instead of sky-gazing; of improving idle moments by controlling our thoughts and directing them into useful channels.

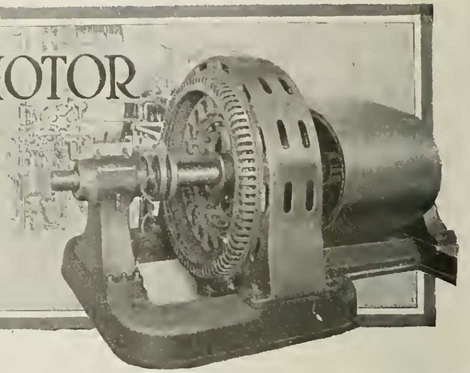
Cannot certain nights in each week or some of the week-end hours be regularly reserved for useful pursuits, for educational reading or recreational hobbies? Then one will have the satisfaction that at least a portion of his surplus time is productively applied, and in later years he will be spared the remorseful query, "What have I done with my Opportunities?"

Contributed by H. T. MOORE

THE SYNCHRONOUS MOTOR IN OPERATION

By

Will Brown*



Horseshoe magnet illustrations make it easy to understand the operation of the synchronous motor under load, the difference between it and the induction motor, the starting operations, the importance of pull-in torque and its relation to starting torque. Increasing use of the motor for driving machines of constant speed.

IN FIGS. 1 to 4, are illustrated the actions of a synchronous motor when running under load. Two horseshoe magnets represent the stator field and rotor field. Line current is represented by the upper hand grasping the stator magnet. Mechanical load on the motor is represented by the lower hand grasping the rotor magnet. The arrow indicates the direction in which the stator magnet is moving. The rotor magnet being locked with it, is moving at the same speed. Fig. 1 indicates the position of the stator and rotor poles (magnets) when the motor is in step with the line and running with no load. Notice that the south pole of the rotor is exactly opposite the north pole of the stator, and vice-versa. The center points of the stator poles, *A* and *B*, coincide with *A′* and *B′*, the center points of the rotor poles. When the motor is carrying load the relative position of the stator and the rotor poles is shown in Fig. 2. Notice that points *A′* and *B′* of the rotor have slipped back from *A* and *B*. Remember that the stator magnet automatically increases in power as the rotor magnet slips until a point is reached where the pull of the line balances the pull of the load. Fig. 3 shows the position of the stator and rotor poles when the load on the motor has pulled the rotor back half the distance of a pole face. Notice that the north pole of the rotor is only half covered by the south pole of the stator, and that the north pole of the stator now repels the north pole of the rotor. The line current is very heavy and the motor is unstable as it approaches this point.

In Fig. 4 the load has literally pulled the rotor poles away from the stator poles. As soon as the point is reached where the north pole of the stator opposes the north pole of the rotor the pull of the line snaps like a rubber band and the rotor is brought to a dead stop by the heavy pull of the load.

If one keeps this picture in mind of the magnets of the stator constantly dragging the magnets of the rotor it will be easy to point out the difference between the induction and synchronous motor. An induction motor can develop no torque unless the rotor bars are cutting lines of force from the stator. As soon as the line current is thrown on the stator these lines of force start revolving at synchronous speed just as in the case of a synchronous motor. These lines are cut by the rotor bars and induce a current in them. This current causes a magnetic field to surround the motor bars. This magnetic field forces the rotor forward in an attempt to catch up with the stator field. It is evident, however, if the rotor and the stator are revolving at the same speed, that the rotor bars cannot be cutting any lines of force, consequently there will be no current in the bars and no torque in the motor. For this reason if there is any load on the motor, the rotor must slip back a certain percentage from synchronous speed. This slip speed at full load is known as the motor's rated speed and any addition to the load reduces the speed to some extent. The squirrel cage bars on synchronous-motor pole faces produce the exact duplicate of an induction motor rotor. The starting torque (in proportion to kv.a. input) will be higher gen-

VERTICAL SYNCHRONOUS MOTOR WITH DIRECT-CONNECTED EXCITER erally in the case of a synchronous motor than in a squirrel-cage motor. The reason for this will be explained later.

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*Service Sales Manager, Electric Machinery Co., Minneapolis, Minn.

A synchronous motor is started at part voltage as an induction motor and quickly comes up to a certain slip speed. At this point the synchronizing power of the line begins to make itself felt. Definite magnetic poles have been built up in the rotor by induction in the field windings, since no direct current is supplied to the field until later: Every time a north pole of the stator passes a south pole of the rotor or vice versa, the poles attempt to lock together. But as yet the magnetic pull is not strong enough to get the rotor up to speed. Then the operator throws full voltage onto the motor and this immediately strengthens the stator fields so that its poles can pull the rotor poles along at synchronous speed.

When the load increases on a synchronous motor, the exciting current remaining fixed, the rotor poles drag back a small distance in relation to the stator poles and this automatically causes an increased current to flow from the line into the stator winding. Since there is no corresponding increase of exciting current the power factor tends to become lagging. Conversely when the load is removed and the excitation remains constant the power factor tends to become leading.

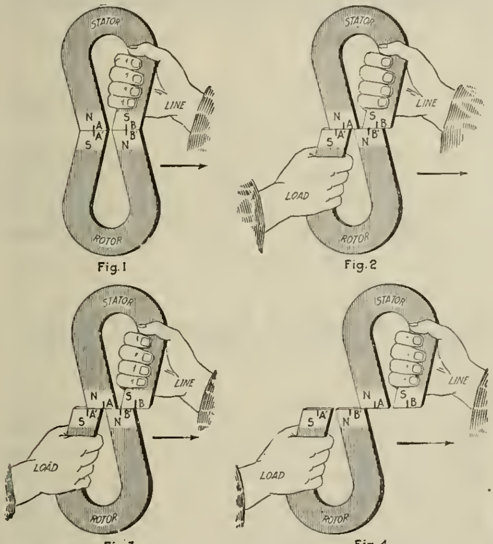

Fig. 1 Fig. 2 Fig. 3 Fig. 4

FIGS. 1 TO 4. SHOWS THE RELATION BETWEEN THE ROTOR AND STATOR POLES OF A SYNCHRONOUS MOTOR

Now if the reader has carefully followed the description up to this point he can form a mental picture of the starting operation. He can also understand the importance of the synchronozing power or pull-in torque of a synchronous motor. It is this feature of pull-in that limits the starting torque as well.

To explain this point by a mechanical means consider the illustration in Fig. 5. Two concentric disks S and R are revolving at different speeds on the same shaft; S represents the stator field, R the rotor field, A is a slot on disk R and P is a plunger on disk S which will automatically plunge downward at the instant slot A is passing under it. The two disks will then be locked together. Assume that S is revolving at a fixed speed of 200 r.p.m. and that R starts at zero and increases in speed. In the figure R has arrived at a speed of 100 r.p.m., that is 50 per cent. slip speed. For every one revolution of R two revolutions are made by S.

Now when the plunger P is forced into slot A one of two things will happen: Either disk R must immediately revolve at the same speed as disk S (it is assumed that the speed of S is fixed) or plunger P must break. In either case disk R will receive a jerk. The plunger represents the magnetic pull of the stator. If the plunger breaks, assume a fresh plunger of the same strength automatically takes position ready to lock the disks together when P passes A. But these plungers will all break if the speed of R is not increased. As the speed of R is further increased the jerking strain on each plunger will grow less at each time until there comes a point where the plunger is strong enough to lock the two disks together without breaking. Disk R has been pulled into step with S and now revolves at synchronous speed.

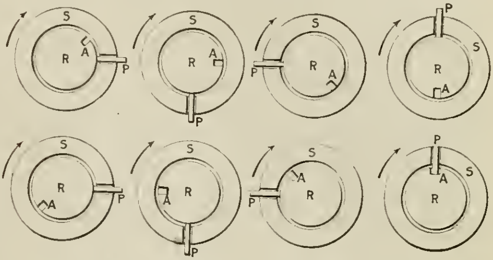

FIG. 5. TWO CONCENTRIC DISKS SHOWING HOW A SYNCHRONOUS MOTOR PULLS INTO STEP

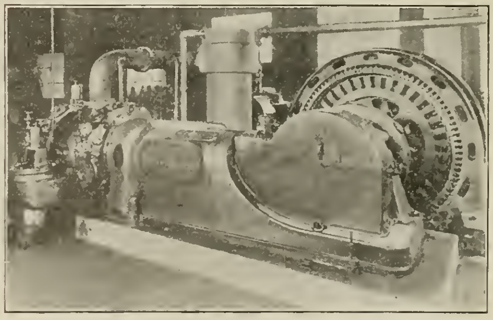
FIG. 6. SYNCHRONOUS MOTOR DRIVING AIR COMPRESSOR

In this operation there are three factors that must be taken into account: The load on R, the slip speed of R and the strength of P. The strength of P is limited by the current which can safely be drawn from the line. The load on R is determined by the characteristics of the machine which the motor must start; as for example, a compressor or a pump. The speed of R must be brought close enough to the synchronous speed that the magnetic pull of the stator can accelerate it to full speed. If a synchronous motor was designed for the highest starting torque possible under induction-motor construction it would have a maximum slip speed so low that it would never be pulled into step. That is why it is necessary to limit the starting torque of a synchronous motor in order to develop sufficient pull-in torque and carry the load under the critical pull-in period.

There are always three important points in the starting of a synchronous motor:

First: It must be able to start up the load from rest.

Second: It must accelerate its load quickly to maximum slip speed.

Third: It must have synchronizing power sufficient to pull the load into step.

As a matter of fact a synchronous motor can be designed for higher starting torque (generally speaking) than a squirrel-cage motor. If the squirrel-cage motor is designed for very high starting torque it means a comparatively poor efficiency at full speed. The synchronous motor can neglect this matter of efficiency at full speed entirely, because once pulled into synchronism its induction-motor characteristics no longer affect it.

Today the synchronous motor is being used for driving machines of constant speed where the starting load can be kept within reasonable limits. They will be found in the shipyards, mines and factories driving air compressors, driving ammonia compressors in ice plants and packing plants, driving the Jordans, grinders and beaters in paper mills, the heavy rolls in rubber mills, centrifugal pumps, some types of reciprocating pumps, fans and blowers and crushing and grinding machines of various types. They are well adapted for heavy line-shaft duty where the fluctuations of load would ordinarily produce low power factor on an induction motor. Many plants are replacing a number of small individual drive machines with group drive in which a fair-sized synchronous motor operates at high efficiency and high power factor.

The practical performance of a synchronous motor can be explained easily to anyone who possesses the mental picture that this article has tried to convey. For instance, it can be seen that the question of flywheel is an entirely different matter with an induction motor which has a slip with every variation of load, to that of a synchronous motor which permits no slip whatever, but does allow a certain angular displacement limited to a brief fraction of a second.

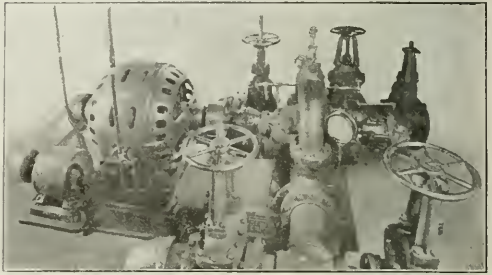

FIG. 7. SYNCHRONOUS MOTOR DRIVING CENTRIFUGAL PUMP

This rugged high efficiency motor is rapidly forcing a place for itself in all kinds of industry. The later designs are superior to older types both in starting torque and pull-in torque, and further improvement can be looked for. No one can say just what the limit will be in this respect.

Methods of Obtaining Close Speed Regulation

BY W. TRINKS*

ALTHOUGH close speed regulation has been sought by engineers ever since prime movers were first built, the degree of closeness actually attained in practice has varied greatly with the increasing demands made by the operation of spinning machinery, electric generators and coke-oven gas exhausters. The process of striving for close speed regulation led many an engineer into wrong paths because conclusions were drawn from incomplete theories.

It is well known that one governor designer after another tried to build a successful isochronous governor—that is to say, a governor that would maintain a truly constant speed—and that one after another they failed. As a rule, the better the governor was in the opinion of the designer, the worse it showed up in practice. The governors designed from 1850 to 1890 all had too much mass and too much friction to be successful. Toward the end of the nineteenth century, high-speed, spring-loaded spindle governors and inertia shaft governors were introduced. The latter type solves the problem of close governing, but attempts made to apply the inertia principle to spindle governors were in the main unsuccessful for this reason: While the inertia shaft governors were used on small engines driving direct-current generators, the spindle governors built on the inertia principle were applied to engines driving alternating-current generators, and the parallel operation of alternators requires that the governor be designed with a steady speed rise between full load and no load. Alternating-current work required perfect speed characteristics, and as soon as spring-loaded, high-speed governors with such characteristics were introduced, the inertia principle offered no advantages, but decided disadvantages, because inertia mass increases the total moving mass of the governor.

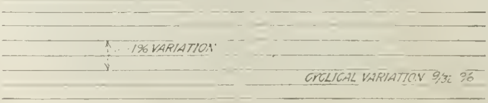

FIG. 1 WAVES SHOWING CHANGE OF SPEED WITH CHANGE OF LOAD

Slowly, step by step, governor designers recognized the necessity of building high-speed governors exerting great force with small mass. Likewise, it took time to recognize the harmfulness of solid friction and the elimination of such harmfulness by vibration. Parsons was the first engineer to intentionally introduce governor vibration in connection with his steam turbine (puff governing). The improvements in governor design allowed gradual approach to isochronism without making it possible to reach it. In a way it will never be reached; sudden changes of load will always produce a change in speed, because it is evidently impossible to produce a centrifugal force without mass. After a few seconds the engine or turbine may regain its original speed, but not until several speed waves have been completed, as shown in Fig. 1. In order to accomplish the return of the speed to the orginal value or very close to the original value, the governor must be equipped with temporary stability, which means it must be so designed that quite a speed change is required to make it move away from its instantaneous position of equilibrium, and that the force compelling the speed change gradually disappears after the disturbance of equilibrium (load change). The first American record of such an arrangement appears to be the description by Mr. Armstrong, of Erie, Penn., of a shaft governor in which a moving piston fits snugly in an oil-filled, elongated cavity of the main centrifugal weight (see Fig. 2). Whenever the governor parts change their configuration—that is to say, when the engine regulates—the main centrifugal weight and the auxiliary weight move as one solid entity, but for every different position of the main weight the auxiliary weight will arrange itself differently relative to the main weight because of the form of the cavity. The arrangement just described has been forgotten because it cannot be applied to spindle governors. On the other hand, the principle in question can easily be applied to spindle governors, as will be seen from Fig. 3, which diagrammatically represents a spring-loaded gagpot. It will be noticed that the main piston of the gagpot floats between springs which abut against the two ends of a hollow box piston. The main piston has a comparatively large hole, while the box piston has a very small hole at each end for the passage of oil. The springs exert a force on the main piston in proportion to its displacement relatively to the box piston and give the governor the required stability, but the box piston gradually yields, the springs lose their tension, and the stability is removed.

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*Professor of Mechanical Engineering, Carnegie Institute of Technology, Pittsburgh, Penn.

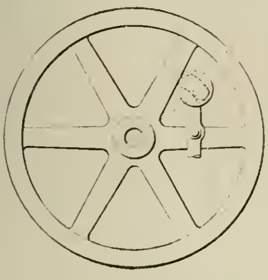


FIG. 2. OIL-FILLED CAVITY IN CENTRIFUGAL WEIGHT

In the United States this principle has been extensively used in relay governors for hydraulic turbines, but there appears to be no application of it in direct control governors. In England, on the contrary, the principle of temporary stability has been extensively used in direct-control governors, of which the "Bee" governor (Eastman's patent) and the Chorlton-Whitehead governor are good examples. The latter is illustrated in Fig. 4. In the language of the builder of the governor, its action is described in the following paragraph:

"The spring on one side is divided into two unequal portions, *A* and *B*, a plate *C* forming the piston of an oil gag being interposed between the two portions. The oil gagpot itself is formed in the weight and is provided with a small adjustable valve *D* by means of which free communication can be made from the gagpot to the body of the governor. The bottom case being entirely filled and the top portion about four-fifths full of oil, the governor is ready for work and the action will be as follows: If the gagpot valve is wide open so that oil has a free passage to and from the interior, the gagpot piston will be quite free to move, and the divided spring will behave as one complete spring, the piston merely acting as a washer. The compound spring in this condition is exactly equivalent to the single spring in the other weight, and both are designed to exactly counteract the centrifugal force of the weights in all positions when running at constant speed; in other words, the governing is isochronous, and to run in this condition would cause it and the engine to hunt violently, as the governor would have no stability. If, on the other hand, the valve is closed, the gagpot becomes immovable and puts the shorter spring out of action. We have thus decreased the effectual length of the spring, and the governor will run with a certain amount, say 8 per cent., of the variation between the inner and outer positions, making the governor very stable—too much so, in fact, for close governing. If now the gagpot valve be partly opened, a point can be found where hunting does not take place, and still the governor will be in equilibrium after a certain time has elapsed, allowing the gagpot piston to move to its new place; in other words, the governor will be isochronous subject to a certain time lag, amounting to two or three seconds.

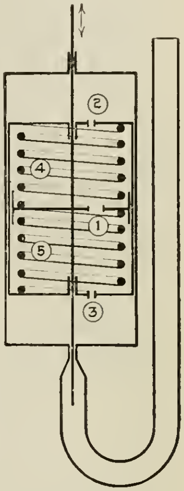


FIG. 3. DIAGRAM OF SPRING-LOADED GAGPOT

Full explanations of the underlying theories and of the applications will be found in the book, "Governors and the Governing of Prime Movers," by the author.

It is necessary to properly pitch and drain pressure pipe lines with pipes of ample size to take care of the rapid condensation of the steam when first turned into the line. If traps are used, they should be located below the line to drain it dry when steam is shut off. It is good practice to put a bleeder on the end of the line farthest from the steam inlet to help remove the rapid condensation which is bound to take place when the steam is first turned on.

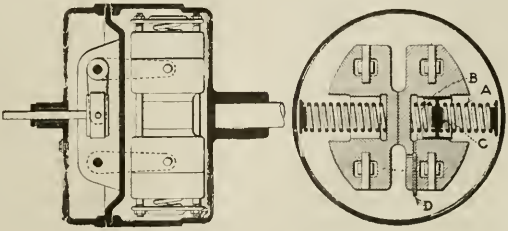


FIG. 4. CROSS-SECTION DIAGRAMS OF THE CHORLTON-WHITEHEAD GOVERNOR

Automatic Pump Control

By B. N. EVERETT

A number of arrangements of automatic pump-control apparatus that have been satisfactorily employed are illustrated diagrammatically, and their methods of operation are explained. These controls are for motor and belt-driven power pumps of both plunger and centrifugal types.

IT IS better economy in some cases to use power-driven pumps rather than direct-acting steam pumps. In plants that can make use of all the exhaust steam from direct-acting pumps and in plants where the load factor is so low that the matter of initial cost controls the selection, steam pumps show better over-all economy, and it is a simple matter to apply automatic control to direct-acting steam pumps. In every power-pump installation the matter of control should be given consideration as it often means the difference between efficient and inefficient operation.

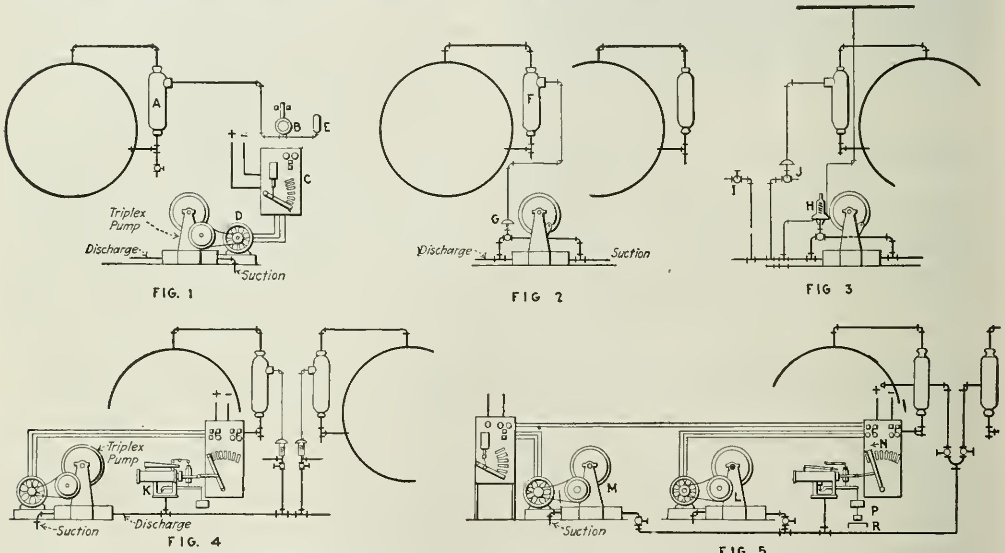
The accompanying sketches show diagrammatically a number of arrangements of automatic control apparatus which have been satisfactorily employed.

Fig. 1 represents an application to a motor-driven triplex pump to feeding one boiler. When the water level reaches the low point, the float-operated pilot valve of the feed-water regulator *A* opens so as to admit pressure from the boiler into the diaphragm chamber of the diaphragm-operated switch *B*. The closing of this switch supplies the current for operating the starting rheostat *C* which controls the pump motor *D*. At high-water level the regulator *A* exhausts the control pressure to the atmosphere and the pump motor is stopped. A small air chamber *E* on the control pipe acts as a dashpot, retarding the operating control in such a manner that it will not be affected by a surging water level. With this control the power consumed is proportional to the quantity pumped.

Fig. 2 control uses a similar feed-water regulator *F* for one boiler, but in this case the pump runs continuously and the control is through the medium of a diaphragm-operated bypass valve *G*. At high water the bypass is open and the pump runs idle. The power consumption in this case is that required to pump the water plus that required to run the pump idly during the periods that the bypass is open.

If more than one boiler is to be fed by a power pump belted to a lineshaft or engine, the arrangement shown in Fig. 3 may be used. This consists of an excess-pressure control valve *H* placed on the bypass of the pump. This valve is adjusted so as to remain open only enough to maintain any desired excess pressure in the feed line above boiler pressure. The feed to each individual boiler is then controlled either by the hand valve *I*, or by the feed-regulator *J*. The power consumed with this arrangement of control equals the maximum capacity of the pump at the operating pressure.

Less power will be consumed when it is possible to change the speed of the pump. An engine-driven pump may be varied in speed by placing a pressure-control valve in the steam line to the engine, as in the case of direct-acting pumps. Figs. 4 and 5 indicate variable-speed arrangements for electrically driven pumps. Variable-speed motors are used, and the regulation is accomplished by means of a pressure-controlled, hydraulically operated rheostat. The hydraulic device is



FIGS. 1 TO 5. SEVERAL TYPES OF POWER PUMP CONTROL

Fig. 1—Motor-driven triplex pump control. Fig. 2—Pump bypass controlled by diaphragm-operated valve. Fig. 3—Bypass controlled by an excess-pressure valve. Figs. 4 and 5—Pump speed controlled by variable-speed motors that are controlled by a pressure-controlled hydraulically operated rheostat.

similar to a hydraulic damper regulator, but the cylinder is horizontal. The power consumption with control, Fig. 4, will vary with the amount of water delivered, but will not be exactly proportional, as the efficiency is less at slow speeds.

In Fig. 5 two pumps are used, one of which, L, is equipped with a variable-speed motor, and the control is the same as shown in Fig. 4. The other pump M is run by a constant-speed motor and is under the control of the self-starter N. At ordinary loads, up to the capacity of the pump L, the control is the same as in Fig. 4. At heavier loads the control is as follows: When the rheostat arm has reached its extreme travel to the left, it makes a contact at N which closes the control circuit of the self-starter. As soon as the pump M starts, however, the pressure will rise, causing the pump L to slow down to a speed only sufficient to maintain the pressure. Pump M then keeps running until the pressure is such as to cause the rheostat arm of pump L to reach its extreme right travel. At the maximum speed of the pump L the weight P comes to rest upon its support R, thereby relieving the diaphragm of so much weight. This action takes place just before the rheostat arm makes the contact at N which starts the other pump. It will be seen, therefore, that even after the pump L has attained its maximum speed, the pump M will not start until there has been a further drop in pressure. The power consumption with this arrangement of control is less than that shown in Fig. 4, as the pumps operate with a better load factor. It is adaptable to classes of pumping requiring varying quantity at uniform pressure.

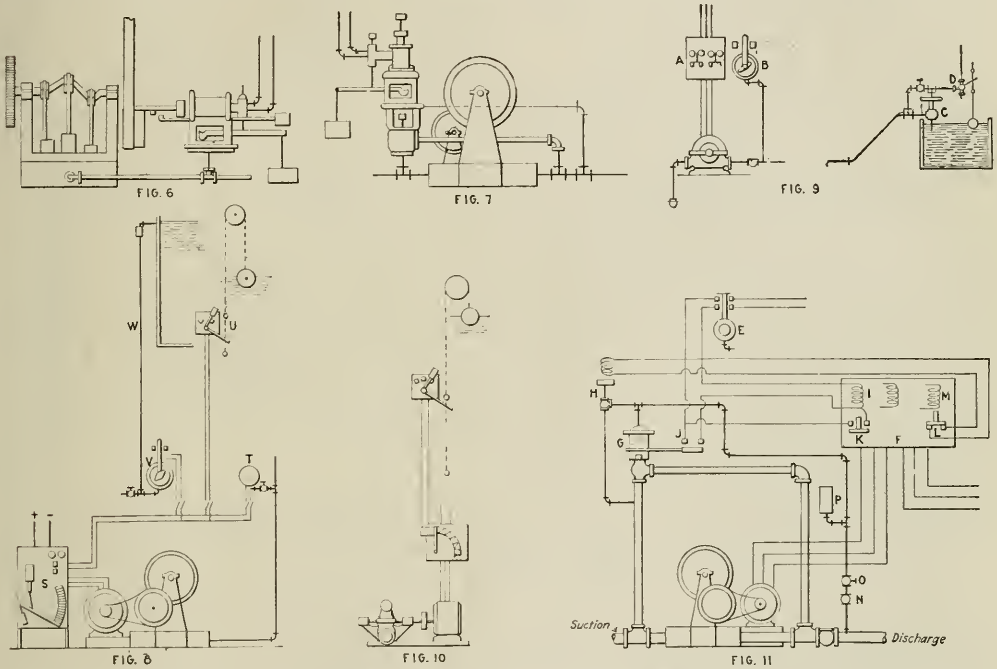


FIG. 6 FIG. 7 FIG. 9 FIG. 8 FIG. 10 FIG. 11

FIGS. 6 TO 11. MORE TYPES OF CONTROL FOR POWER PUMPS

Fig. 6—Control for pumps used intermittently. Fig. 7—Hydraulically operated bypass control. Fig. 8—Control for overhead tank pump. Fig. 9—Control for motor-driven pump at a distance. Fig. 10—Motor-driven tank-pump control. Fig. 11—Control for relieving the load at starting.

Pumps in pressure service driven by gas engines or from lineshafts are often automatically controlled by means of a hydraulic belt shifter, Fig. 6. It is similar to the hydraulic mechanism which operates the rheostat in Fig. 4, but it is provided with an auxiliary weight which is lifted from the diaphragm at the idle position of the shifter. It provides that a drop in pressure of a predetermined amount takes place after the pump has been stopped, before it will start again. The same device may also be used to operate a friction clutch. The control is preferable for service where the pump is idle much of the time, as there is a saving of power over that shown in Fig. 7; but when the control is very intermittent, as in hydraulic-elevator service, most engineers prefer the hydraulically operated bypass valve arranged similar to that which is shown in Fig. 7.

Fig. 8 indicates different methods of controlling pumps supplying overhead tanks. As shown, S is an automatic motor starter which may be controlled by the different pilot switches shown; T indicates a pressure-gage type of pilot switch (if the friction head is considerable, or if there are service connections between the pump and tank which might reduce the pressure, this control is not practical); U represents a pilot switch closed and opened by a float; V represents a diagram type of pilot switch connected in such manner that when the tank is full the pressure pipe fills with water. When the water falls below the pressure-pipe connection, the pressure is relieved through the drip valve at the bottom and the pilot switch closes.

Controls T and U are adjustable both as to starting and stopping levels, but the control V is not adjustable

The small reservoir at the top of the control pipe is uncovered.

Fig. 9 represents an arrangement of control of a motor-driven pump, located at a distance, through the medium of its discharge pipe. The control apparatus consists of a self-starter *A* and a diaphragm switch *B*, similar to that used in Fig. 1; a diaphragm-operated balanced valve *C* and a float-operated three-way pilot valve *D*. The pilot valve is connected to a source of water under pressure. When the reservoir is full, the float-operated pilot valve admits pressure to the diaphragm chamber of the valve *C*, shutting off the pump discharge. There is a small connection which admits water into the discharge pipe, causing the pressure to rise enough to operate the switch *B* at the pump end of the line. At low water level the float trips the weighted lever of the pilot valve and the pressure is exhausted from the diaphragm valve, which opens and the pump starts.

Figure 10 shows a simple idea for stopping a tank-pump motor. It consists of a float switch in series with the magnet of a starting rheostat. The switch opens when the tank is full and the rheostat arm flies back, stopping the motor. It must be started by an attendant.

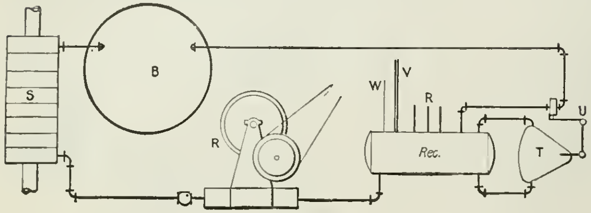


FIG. 12

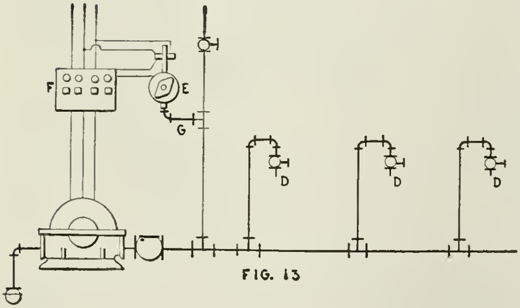


FIG. 13

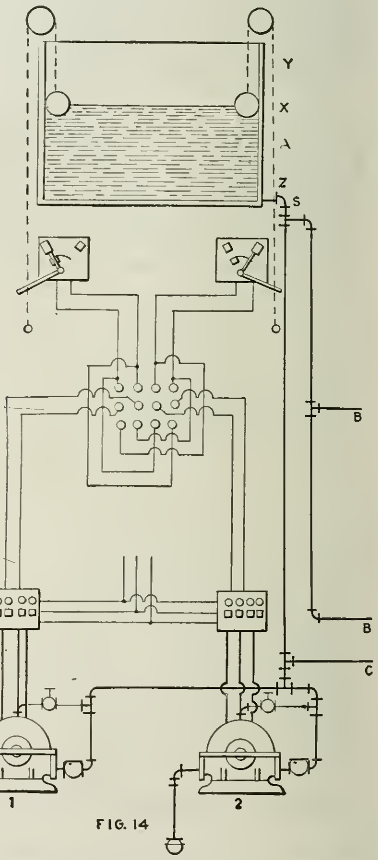


FIG. 14

FIGS. 12 TO 14. SOME SPECIAL CONTROL SYSTEMS
Fig. 12—Control for a return power pump. Fig. 13—Control for motor-driven pump handling warm water. Fig. 14—Control for two centrifugal motor-driven pumps

When squirrel-cage motors are used to drive reciprocating power pumps, means must be provided for relieving the load at starting. This may be done by opening a bypass valve and closing it after the motor has come up to speed. It is, however, desirable to keep the bypass closed while the pump is idle, because then if the discharge check-valve leaks, both the discharge and suction valves must also leak before water will slip back.

Fig. 11 shows the control diagram for the conditions just described. It consists of a pilot switch *E* which may be of the diaphragm-operated type or float-operated; a magnetic self-starter *F*, a diaphragm-operated bypass valve *G* and a magnetic pilot valve *H*, together with two spring control switches *J* and *K* and another one *L* which is normally closed. When the pressure of water level falls to the point for which the switch *E* is set, the switch closes, thus energizing the solenoid that opens the pilot valve *H*. This relieves the pressure in the diaphragm chamber of the bypass valve *G*, permitting it to open and, through the medium of a small lever connected to the valve stem of the bypass valve when in its wide-open position, closes the control switch *J*, which furnishes the control circuit to the self-starter solenoid *I*. The control switch *K* is closed by the action of the solenoid *I*, which also closes the first switch of the starter *F*. This switch, not being part of the special control, is not shown. The control switch *K* is in parallel with the control switch *J* and supplies current to the solenoid *I* after the bypass has closed again and the control switch *J* is opened.

A solenoid *M* represents the final switch magnet which throws the motor directly across the line, after it has properly accelerated. Besides closing the motor switch (not shown), it opens the control switch *L*, which causes the pilot valve *H* to close when the pressure from the discharge side of the discharge check-valve closes the bypass. At the required pressure or water level the control current is cut off and the motor switches open. A strainer *N* is connected in on the control pipe; *O* indicates a small valve for throttling the control pressure and *P* is a small air chamber. The function of *O* and *P* is to cause a small interval of time after the main switch closes before the by-pass valve closes.

A special pump application and method of control is shown in Fig. 12. In this case the pump *R* handles the return from the heating system receiver and discharges it to the low-pressure heating boiler after passing through a heater *S* using exhaust from the gas engines which run the plant. The pump is run continuously to insure the heater from burning and to accomplish as great a heat transfer as possible. As the pump has a greater capacity than the returns alone will supply, a makeup connection is taken from the boiler and it is controlled by a float *T* and a balanced valve *U* so as to maintain a constant water level in the return receiver. When the heating load is not heavy, the heat from the gas-engine exhaust is enough, so no fire is required under the boiler *B*. The cold makeup-water connection is balanced at *W*, and *V* indicates an atmospheric vent pipe.

Control for Two Centrifugal Motor-Driven Pumps

In Fig. 14 is shown an arrangement of the control for two centrifugal motor-driven pumps, pumping water for cooling gas engines and for general service. The tank is for control purposes only and is not intended to furnish water except for a very few minutes. The control is similar to that shown at *U*, Fig. 8. Pump No. 1 starts when the water has reached the level indicated by *X* and stops at *Y*. Pump No. 2 starts only when the water level in the control tank has fallen nearly to the bottom of the tank, or point *Z*, and stops when about at *A*. The service connection *B* being just under the tank and the connection to the gas engines *C* being near the pumps, insures that if the water being pumped is less than what is required, the available supply will go to the gas engines first. Each pump has a capacity that exceeds somewhat the maximum demand for cooling water.

With this arrangement if one pump goes out of commission the other takes on automatically as much of the work as it can do and the gas engines are served first. Each pump is fitted with a foot valve and a small bypass to the top of the casing. This bypass keeps the pump from becoming airbound and is properly a part of the control system. The pilot-switch control circuits pass through a four-pole double-throw switch, as shown, which permits an equalization of the work from day to day.

The characteristics of centrifugal pumps are such that automatic control may be applied by simply throttling the discharge. The efficiency at reduced capacity is poor, and considerable power is consumed when running idle. It is best when conditions permit to use a system of control which starts and stops the motor.

Fig. 13 illustrates a motor-driven pump handling warm water, discharging it to finishing machines in a woolen mill. An operator desiring to fill one of the machines simply opens the valve at his machine *D*, and the pump starts. When he shuts the valve, the pump stops. The motor is controlled by a pressure-operated switch *E* and an automatic switch *F*. A small connection *G* from an overhead tank is used to maintain the pressure, which holds the valve *E* open as long as the valves *D* are all closed. When the pump is running, a small amount of cold water is added through the connection *G*, but the amount is negligible.

Pilot Lights, Electric Meters, Etc.

The operation of automatic apparatus may be checked and observed at a distance by means of telltale pilot lights, electric meters, etc. For example, an engineer has on his gageboard an ammeter indicating the current consumption of an electrically driven pump a mile away, also a long-distance level indicator which shows the level in the reservoir served by the pump. On the level indicator he has marked the point at which the pump stops and starts, and the ammeter not only tells him when the pump is running, but gives an indication of abnormal conditions. If an oiler has tightened the glands so as to cause excessive friction, the current consumption will be greater than normally. If a pump valve is broken, the current will fluctuate with each revolution of the pump, or if the pump becomes badly airbound or loses its suction, the current consumption will be abnormally low, and as the control circuit passes through his engine room, he may stop the pump and send an attendant to correct the trouble. Automatic control not only frequently means a saving in the wages of a pumpman, but the pumps actually get better attention under the occasional examination of an expert than they would with a poorly paid pumpman.

The results of an investigation into the speed of rusting of steel containing small proportions of copper are given by Mr. D. M. Buck in a paper read before the American Society for Testing Materials. This research has determined that the principal protective effect is exerted by proportions of copper so small that most analysts would report them only as traces. Increasing the copper content from 0.01 per cent. to 0.03 per cent. decreases the corrosion by 30 to 40 per cent. With a normal sulphur content of about 0.05 per cent., a copper content of 0.12 per cent. gave virtually as complete protection as larger amounts. A copper percentage of 0.15 per cent. is considered sufficient to protect steel even with considerable excess of sulphur.

In any work of babbitting all preparations should be made in advance of the heating of the metal such as cleaning and heating the bearing shells and making the molds or dams for pouring. Never pour babbitt into wet or damp castings. After a bearing is cast do not forget to drill the oil holes and cut the oil grooves before scraping and do not cut the grooves too deep or too near the ends of the bearing.

Loss Due to Carbon in Furnace Refuse

BY C. H. BERRY*

IT is common to treat as pure carbon the combustible which passes through the grates or over the dump plates together with the ash. The causes of this loss are worthy of detailed study. In hand-fired furnaces some fine coal may fall in a hole in the fire, where the grate is bare or nearly so, except for a layer of ash. The green coal lying where the hole formerly was, will impose increased resistance to the flow of air and will for a time be at relatively low temperature. The fine coal at the bottom will be the last to reach the temperature of the fuel bed and may easily drop through the grate before it has an opportunity to burn, especially if the coal lying above it forms clinkers which further interfere with the air supply.

Another cause of this loss is the use of the hook or slice-bar on the fire. This operation will rake a certain amount of coke through the grates and will mix ash and coke together above the grates, making the combustion of such coke less likely, with an increased probability of losses.

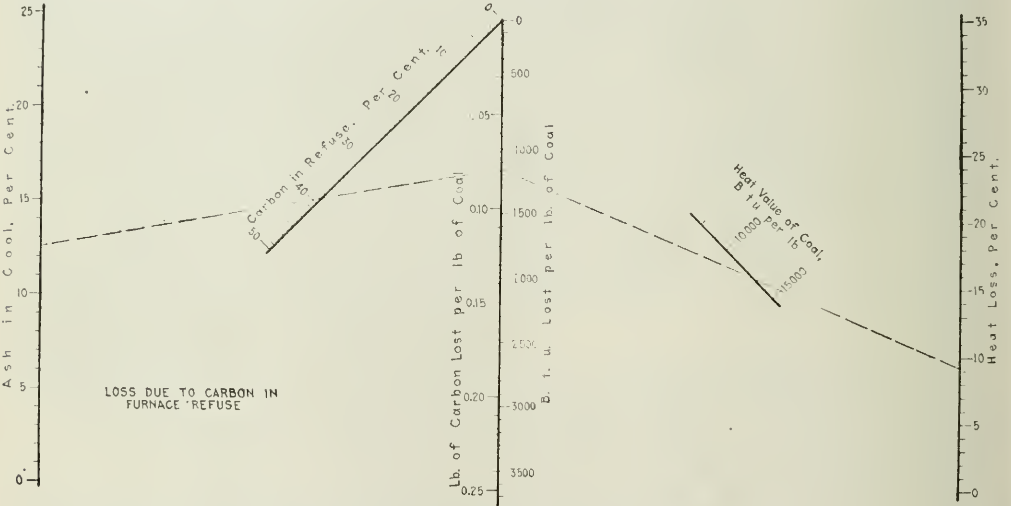


FIG. 1. CHART FOR FINDING LOSS DUE TO CARBON IN FURNACE REFUSE

In stoker-fired furnaces there is not the same likelihood of loss through holes in the fire, but under certain conditions unburned coke will reach the tail end of a chain grate or the dump plates of an underfeed or overfeed stoker and will there mingle with the ash and pass into the ashpit. The increase of this loss due to the use of the hook or slice-bar holds in the case of stoker firing as for hand-firing.

The losses resulting from the failure to burn this lost coke depend upon two factors—the percentage of ash in the original coal and the percentage of carbon in the furnace refuse. Both of these quantities are determined by laboratory analysis of samples of the coal and refuse respectively. That we may reach a correct method of computing the heat loss, let us examine the problem in detail.

The ash in the coal fired either passes up from the fire as dust or drops of molten slag, or else passes down into the ashpit. Since the proportion of the total ash that passes up from the fire is small, it can safely be neglected for the present purpose. Assume, therefore, that all the ash in the coal passes down to the ashpit. Along with it there also passes down a quantity of coke. The diagram, Fig. 1, will help to make clear the relations involved. The coal fired is assumed to have the composition: Moisture, 5 per cent.; volatile matter, 34 per cent.; fixed carbon, 51 per cent.; ash, 10 per cent. If one pound of this coal be considered, it will contain 0.05 lb. of moisture, 0.34 lb. of volatile matter, 0.51 lb. of fixed carbon and 0.10 lb. of ash, as indicated graphically at the left of Fig. 1. All the ash and some of the fixed carbon contained in the coal pass into the ashpit, and together they make up the furnace refuse.

Assume that an analysis of this furnace refuse shows that it contains 20 per cent. of combustible, which is assumed to be pure carbon. The question now arises, What weight of carbon is lost per pound of coal fired? Since this carbon is known to be 20 per cent. of the total refuse, we shall be able to find the weight of carbon lost per pound of coal if we can figure the total weight of refuse per pound of coal fired. This is easily done because the ash in the coal is all assumed to pass into the refuse. If the refuse contains 20 per cent. of carbon, it must contain 100 — 20 = 30 per cent. of ash But the weight of ash per pound of coal is known, in this case, to be 0.10 lb. This 0.10 lb. of ash forms 80 per cent. of the total refuse. Hence the total weight of refuse per pound of coal fired must be $0.10 \div \frac{80}{100} =$

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*Formerly assistant professor of heat-power engineering, Sibley College, Cornell University.

$\frac{0.10}{0.80} = \frac{1}{8}$ lb. The weight of carbon lost is 20 per cent. of this, or $\frac{0.10}{0.80} \times 0.20 = 0.025$ lb.

Putting this computation into general terms to apply to any numerical case, we have

Per cent. ash in refuse=100—*Per cent. carbon in refuse*

and

$$\text{Total weight of furnace refuse} = \frac{\text{per cent. ash in coal}}{100} \times \frac{100}{\text{per cent. ash in refuse}} = \frac{\text{per cent. ash in coal}}{\text{per cent. ash in refuse}} = \text{pounds of refuse per pound coal}$$

The weight of carbon lost is then

$$\text{Pounds of refuse per pound of coal} \times \frac{\text{per cent. carbon in refuse}}{100} = \frac{\text{per cent. ash in coal}}{\text{per cent. ash in refuse}} \times \frac{\text{per cent. carbon in refuse}}{100}$$

This may just as well be written:

$$\text{Pounds of carbon lost per pound of coal fired} = \frac{\text{per cent. ash in coal}}{100} \times \frac{\text{per cent. carbon in refuse}}{100 - \text{per cent. carbon in refuse}}$$

Now let us compute the heat lost per pound of coal. One pound of carbon has a heating value of 14,600 B.t.u., so that the heat lost due to unburned carbon in the refuse will be

$$\text{Pounds of carbon lost per pound of coal fired} \times 14{,}600 = \text{B.t.u. lost per pound of coal fired.}$$

The percentage heat loss will be

$$\frac{\text{B.t.u. lost per pound of coal fired}}{\text{Heating value of the coal as fired}} \times 100.$$

These formulas have been combined in the alignment chart given in Fig. 1, in which the left half gives the pounds of carbon lost per pound of coal and the B.t.u. lost per pound of coal, for given values of the percentage of ash in the coal and the percentage of carbon in the refuse. The right half of the chart gives the per cent. of heat loss from the known result found from the left half of the chart together with the known heating value of the coal.

An examination of the chart will indicate that the extent of this heat loss may be considerable. For example, if we fire a coal containing 12.5 per cent. of ash, and if the resulting furnace refuse contains 38.7 per cent. of carbon, the weight of carbon thus lost will be 0.079 lb. of carbon per pound of coal fired. This results in a loss of 1160 B.t.u. per pound of coal fired. If the heat value of the coal is 12,700 B.t.u. per lb. this heat loss will be 9.2 per cent. of the heat value of the coal, which is the basis used for figuring all the heat losses in the furnace, boiler and setting. It can readily be seen that for higher percentages of carbon in the refuse this loss may be an even larger proportion of the heating value of the coal. It should also be noted that a higher ash content of the coal, with the same percentage of carbon in the refuse, will also give a larger heat loss. This is one reason, though a minor one, why high-ash coals do not permit as high boiler efficiencies as obtainable with higher grades of fuel.

Since this heat loss is by no means negligible, it is worth while to consider means for its reduction. From the discussion of the causes of this loss one important means of reduction is obvious—avoid all unnecessary barring and raking of fires, whether hand or stoker fired. Of course, working the fires with the hook or slice-bar is unavoidable at times, but such treatment of the fires should be reduced to the least possible.

Another means of reduction is to maintain conditions such that material passing to the ashpit will have an ample supply of air while it is still at high temperature. With hand-fired furnaces of the usual type little can be done in this line, but when shaking or dumping grates are used, care should be exercised to make sure that the material shaken or dumped is as free from combustible as it is possible to keep it. To make this easier, a layer of ash should be carried under the active part of the fire bed. This will give the additional benefit of protecting the grate bars against excessive temperatures. In the case of stoker firing much depends on the type and design of stoker. In the chain-grate type the speed of travel, the thickness of fuel bed and the air supply can all be controlled more or less completely. The ideal adjustment would be such that the ash is completely burned out just as it reaches the tail end of the grate. This would leave no portion of the grate covered by dead ash and would give no loss of carbon in the asphalt. Such an ideal is clearly impossible in daily operation.

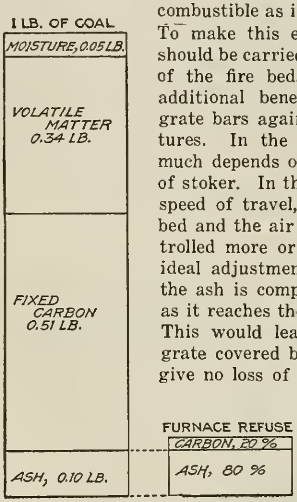

FIG. 2. CONSTITUENTS OF THE COAL

In the case of stokers equipped with dump plates or clinker grinders, the loss may be reduced by supplying air to the material lying on the dump plate or over the clinker grinder. There is, however, a distinct limit to the extent to which this can be carried, because there is grave danger that we may in this way supply a great excess of air to the furnace, thus increasing the volume (and hence the weight) of hot gases passing up the stack. This will increase the stack loss far more than any saving due to reduced carbon in the refuse. Hence this method of reducing the loss due to unburned carbon with the ash should be applied with caution.

A further objection to supplying too much air at the dump plate is that it may fail to effect any saving in the carbon lost, because the combustion of coke mixed with a large proportion of ash is a difficult matter. Too vigorous an air supply will simply cool this coke and put out any fire that may exist. The air supply should be just sufficient for the purpose and should flow gently through the bed of mixed ash and coke.

In this connection clinker grinders, as applied to several types of stokers, are a considerable help. When a dump plate is dropped, everything above it falls directly into the ashpit, from the bottom of the pile, which may perhaps be pure ash, to the top, which may consist to a large percentage of unburned coke. With the clinker grinder, on the other hand, material is constantly removed from the bottom only, leaving the upper part of the pile undisturbed. As this material slowly works its way down to the clinker grinder, it has ample time to burn out as completely as possible if an adequate quantity of air is supplied. The heavy bed of hot ash serves to restrict the air supply, to preheat it before it strikes the burning carbon, and to reduce its velocity so that it is less likely to extinguish such coke as may be burning. In one series of tests with which the writer is familiar, the introduction of clinker grinders made possible a reduction of the carbon in the refuse from about 20 per cent. to less than 0 per cent.

The extent to which this loss may be reduced depends upon many things, but it seems that under fair operating conditions it is reasonable to expect not more than 20 per cent. of carbon in the refuse, and under good conditions not exceeding 10 per cent. The corresponding heat losses will then be less than 5 per cent. and may be as low as 1 per cent. under favorable conditions. A series of 77 tests conducted at the St. Louis plant of the United States Geological Survey showed an average heat loss a little under 5 per cent, and these tests were made under operating conditions, using coals of a wide range of quality.

Home-Made Oiling System

By John C. Kahl

When about to install an oiling system, as described herewith, first obtain two galvanized iron tanks such as are shown in Figs. 1 and 2. The drain tank and strainer, Fig. 1, should be placed in any convenient position below the level of the engine. It is provided with a cheesecloth strainer, held in place by a ring, into which the waste oil is discharged. After being strained, the oil drops to the bottom of the tank, where the impurities settle. The tank is provided with a gage-glass to indicate the height of the water and is drained through a pipe in the bottom.

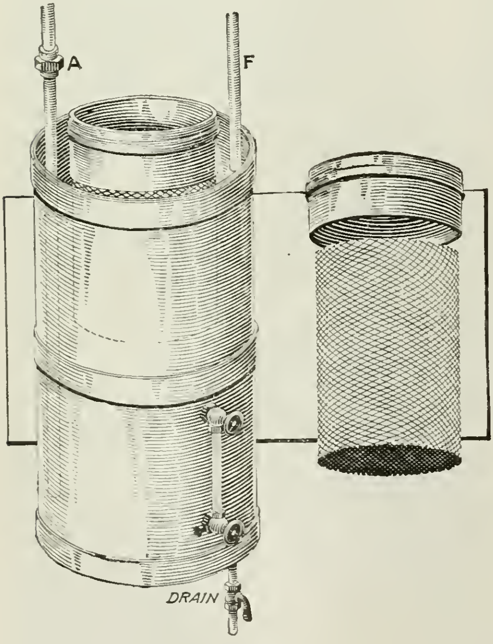

FIG. 1. DRAIN TANK AND STRAINER

The storage tank, Fig. 2, is suitably elevated, which can be done by fastening a couple of pieces of I-beam to the wall at such a distance from the roof as to allow the strainers to be easily changed. This tank is also provided with a gage-glass and is drained at the bottom. It contains two cheesecloth strainers, so that one can be changed without interfering with the filtering of oil. A three-way cock *B* serves to change the oil from one strainer to the other.

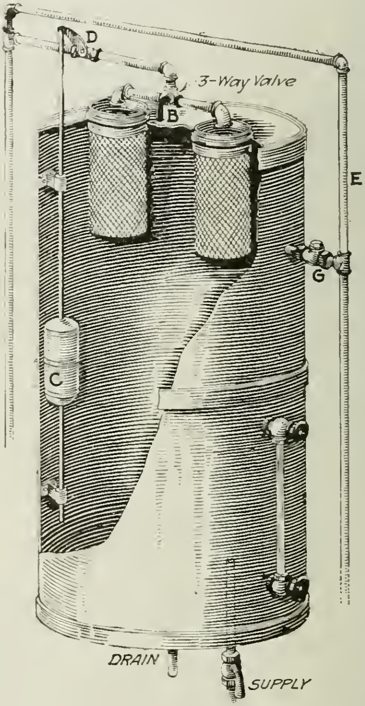

FIG. 2. STORAGE TANK AND STRAINER

In Fig. 3, upper left-hand corner, is shown a small plunger pump which may be so placed that a small connecting-rod can be attached to the rocker-shaft or other convenient part of the engine to give the proper stroke to the pump plunger. In the case of a Corliss engine it may be easily attached to the wristplate. The pump is preferably operated continuously while the engine is running. The suction pipe is run to the basement and enters the drain tank at *A*, Fig. 1. The discharge of the pump is run to the top of the storage tank, Fig. 2, where the oil is discharged into one of the strainers, the flow being governed by the three-way valve *B*. The height to which the oil can rise in the storage tank is governed by the float *C*, which will either open or close the butterfly valve *D*, as the height of oil requires. Should the float close the valve, the oil will continue to rise in the pipe passing over and down pipe *E*, which connects with pipe *F*, Fig. 1, entering the top of the drain tank.

In the event of disarrangement of either the float *C* or the valve *D* so that the latter does not close, the oil, upon reaching the proper height, will flow through the overflow *G*, Fig. 2, which is provided with a check valve to prevent oil filling the tank when bypassing.

The supply pipe is connected to the bottom of the storage tank, the end of the pipe projecting into the tank, and is carried to the engine to be served, suitable smaller pipes being connected for supplying the various bearings.

An ordinary oil cup is used with this system (Fig. 3), the top being tapped at *H* for a ¼-in. supply pipe.

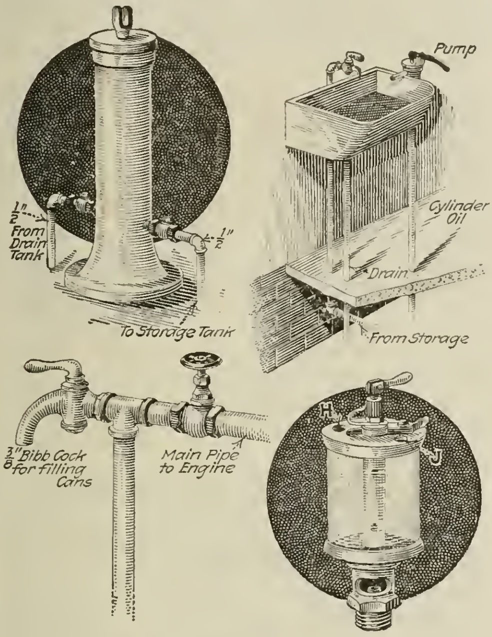

FIG. 3. PUMP, OIL CUP AND PIPING FOR FILLING HAND OIL CANS

The hole *J* represents the original filling hole, which is tapped for a ¼-in. plug. Should an accident occur to the oiling system, the plugs can be removed and the cup filled from an oil can.

A place can usually be provided in the basement for a cylindrical oil tank. A convenient outfit consists of a galvanized-iron oil sink (see upper right-hand corner, Fig. 3), equipped with a small hand pump, for drawing cylinder oil from the tank. A drain pipe from the sink discharges into the engine-oil tank in the basement. A pipe should be run from the engine-oil main supply pipe to the sink, where it is provided with a ¼-in. bib cock for filling oil cans, shown in detail at the lower left-hand corner, Fig. 3.

A recent British invention has been made whereby the piston of an internal-combustion engine may be cooled by means of a draft of air circulating through a space in the piston. The draft is provided by means of fan blades on the engine flywheel. On either side of the hollow piston are ports which register with corresponding ports in the cylinder walls at the end of the stroke. A draft of air is thus forced through the hollow space in the piston while all the ports are in line.

Reels to Prevent Conductors Kinking When Being Installed*

By Terrell Croft

Reels should be used for carrying the coils of wire that is being pulled into a conduit. It is most important that this direction be followed where a number of conductors are being drawn into the same tube. The reels prevent kinks and tangles. The time that they save much more than justifies their expense. A single-coil reel may be made as illustrated in Fig. 1. It comprises two cross-sticks *S* fastened together at their center and rotating on a bolt. Casters are attached to the ends of these pieces so that the reels will rotate readily. The sheet-iron disk *D*, resting on two timbers, provides a smooth track on which the reels can run. A stationary guide arm *A*, through which the conductor being drawn in is passed, tends to prevent the reel from turning when the wire is not being drawn off and minimizes twisting and kinks.

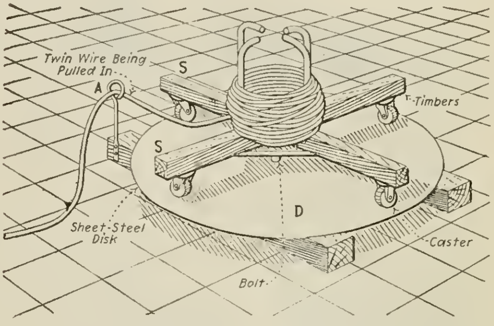

FIG. 1. EASY-RUNNING TWIN-WIRE REEL

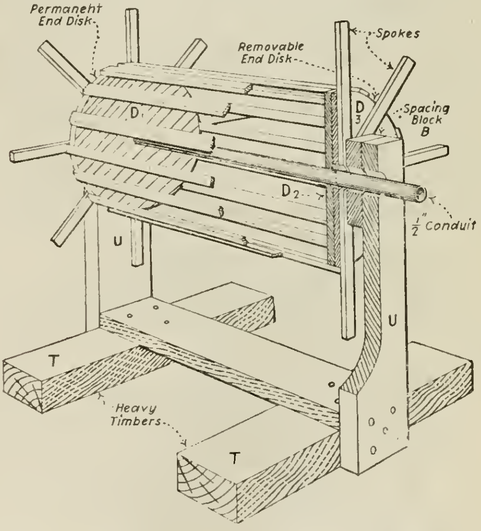

FIG. 2. REEL FOR CONDUCTORS THAT ARE BEING PULLED INTO CONDUIT

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*Copyrighted, 1919, by Terrell Croft.

A wooden reel which may carry one or more coils may be constructed as in Fig. 2. The slats ($\frac{1}{2}$ x 1 x 20-in.) comprising the cylindrical portion of the drum are nailed to two disks, D_1 and D_2, which are about 12 in. in diameter and $\frac{3}{4}$ in. thick. Spokes ($\frac{7}{8}$ x $1\frac{1}{2}$ in.) are fastened on D_1. Disk D_2 is made removable and also has spokes attached to it. The axle is a piece of $\frac{1}{2}$-in. conduit passing through $1\frac{1}{8}$-in. holes. The spacing block *B* can be removed to allow taking out risk D_3. The uprights *U* are 2 x 6-in. pieces. Timbers *T* and *T*, which are heavier than is necessary for mechanical reasons to prevent tipping, constitute a base. When mounting a coil of wire, the reel is taken from the frame and the removable disk D_3 drawn out. Where two wires of the same diameter are to be pulled in, the coil is divided into two approximately equal portions and one portion is reversed. Then both are slipped over the reel. When more than two conductors are to be drawn in simultaneously, additional coils can be mounted on the cylinder as required. Then the cylinder is remounted in the frame and the conductors are ready for pulling into the conduit.

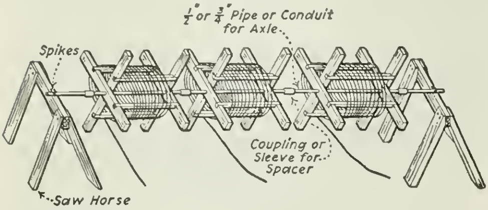

1/2" or 3/4" Pipe or Conduit for Axle
Spikes
Coupling or Sleeve for Spacer
Saw Horse

FIG. 3. MULTIPLE REEL FOR THREE COILS

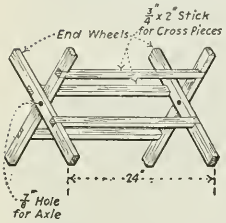


FIG. 4. WIRE REEL UNIT ASSEMBLED

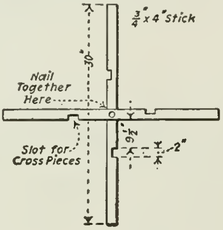


FIG. 5. DETAILS OF END WHEEL FOR REEL FIG.

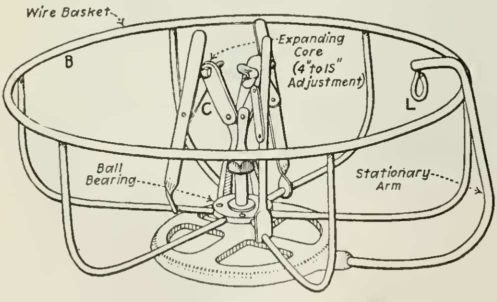


FIG. 6. METALLIC WIRE REEL TO PREVENT KINKING

A multiple-reel arrangement, Fig. 3, may be readily assembled. The supporting axle, which is a length of $\frac{1}{2}$-in. or $\frac{3}{4}$-in. conduit, is sustained by two sawhorses. Couplings or nipples which will slip over the axle are used as spacers between the reels to prevent interference. Each component reel is made as suggested in Fig. 4. The end wheels are detailed in Fig. 5. One end wheel of each reel should be held in its reel with wood screws, so that it can be removed readily to provide for the mounting of a coil of wire.

The reel shown in Figs. 6 and 7 is constructed entirely of metal. The coil of wire rides in a basket *B* and is held in position by an expanding core *C*. The reel turns on a ball bearing, which renders oiling unnecessary. The wire is fed out through a loop *L*, on a stationary arm. Hence, when pulling ceases the reel automatically brakes itself. It is made in two stock sizes of 12 in. and 24 in. outside diameters. The weights are 6 lb. and 12 lb. respectively.

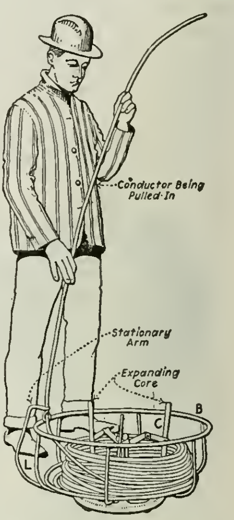
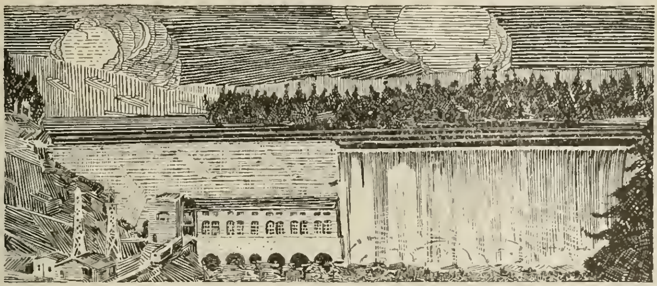


FIG. 7. WIRING REEL IN USE

Danger of High-Potential Currents

Employees should be taught that high-potential currents are dangerous to life, and they should know the voltage carried by every conductor in their station or under their supervision, says *Electrical Safety Magazine.* They should be instructed that not only the bare conductor but the insulation as well, on high-voltage conductors, should not be touched or closely approached. A wire insulated for and carrying a potential of 110 volts, might be, and is, reasonably safe to handle; but the same or similar wire, carrying a potential of 1000 volts, although to all appearances perfectly insulated and harmless, would be extremely dangerous to handle, and the higher the voltage the greater danger to life.

It cannot be too often repeated or too strongly impressed upon all the employees that insulated, as well as bare, cables or wires carrying high potentials are dangerous to handle or approach, unless they are inclosed with a grounded metal sheath. Insulation on high-tension conductors gives a sense of false security to the uninstructed, and many serious accidents to employees have occurred because a conductor was thought to be safe because it was insulated. It is the old story of "Didn't know it was loaded." Electric current at high potential will jump from a conductor through some insulation, and it is not necessary to make actual contact with a high-voltage conductor in order to receive a fatal shock. This matter of not placing too much dependence as far as personal safety is concerned on the insulating covering of wires is often neglected in the instruction of new men, and it is something that should be thoroughly explained and understood by all operators and linemen.



POP'S WATER-POWER COURSE

By

John S. Carpenter

"BROADLY speakin'," said Pop, after he and Jimmy had found a table in Casey's Grill and Cabaret, "they is only two settin's for a turbine. One is what you call 'inside gate mechanism' an' the other 'outside gate mechanism.' In the first type the water comes in contact with all the gate-regulatin' apparatus, an' which I call inside gate-regulatin' mechanism, and in the other the gate levers, links, etc., are protected from the water."

"What determines whether the setting will be inside or outside? Is it a question of cost or the hobby of the engineer?" asked Jimmy.

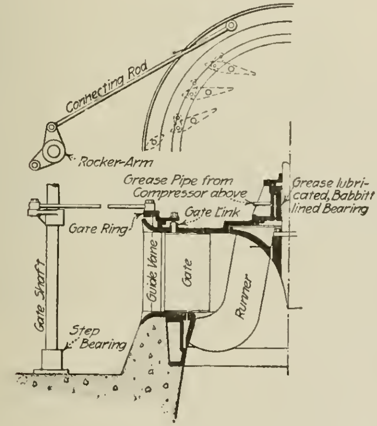


FIG. 1. INSIDE TYPE OF GATE REGULATION

"Both, although a turbine of a given type with inside gate-regulatin' mechanism will cost about 25 per cent. less than the same machine arranged for outside gate control. Some engineers claims the water acts as a lubricant, an' they tells of a big Pelton-wheel plant out West on the far side of the Truckee, with somethin' like 12-in. bearin's that only used water for a lubricant an' been runnin' fine for ten years. It's true that water is a lubricant, to a certain extent, but I don't think you can beat oil at it. The water that circulates around them gate links an' other things on the turbine is often fulla sand an' fine silt that might jes' as well be an emery wheel workin' on them parts. An' as for the outside gate mechanism, it can't be denied that the silt does git into the packin' on them gate stems an' keeps on scorin' right along. An' the fact that you have packin' on the gate stems to keep the water out increases the friction the governor has to work against; although if there is silt an' mud around the gate connections, as it usually is in the inside type, I don't see that they is any more friction in the outside type than they is in the other. Fig. 1 shows the inside type of gate riggin' an' Fig. 2 the outside type as it is usually set in a concrete penstock. The parts is all named for your convenience. This type of settin' is usually called the open-flume type.

"In plants where the head is much over 50 ft. another type of mountin' is used. Here the turbine may often be put in a steel case an' may have the water comin' in from a pipe line on the end, top or side of the case. Then they often puts the turbine into a steel or cast-iron casin' made into a spiral shape, an' while both of these last-named types may have inside or outside gate mechanism, the outside is mostly used. Fig. 3 shows the spiral-case arrangement of outside mechanism. Now in most any of these settin's the shaft may be arranged either vertical or horizontal, the horizontal not bein' as efficient as the vertical, especially on low-head plants."

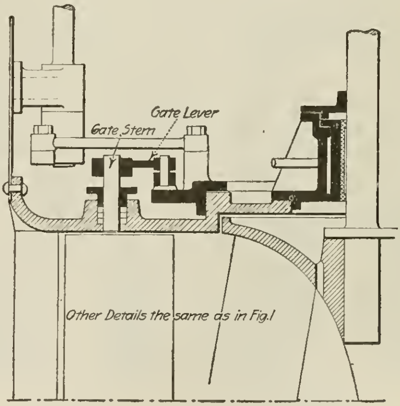


FIG. 2. OUTSIDE TYPE OF GATE REGULATION

Now as to the kind of bearin's on these units. When it is necessary to put the bearin's in the water, they is gen'ly made of lignum-vitæ wood shaped in blocks about like that shown in Fig. 4. Sometimes in very cheap turbines the blocks is made of oak, but oak swells a lot more than lignum-vitæ an' is likely to grip the shaft. Some engineers pokes a good deal of fun at the idee of a vegetable bearing, but the lignum-vitæ stands up pretty well, cases bein' quite common where the wood has only worn down a sixteenth of an inch in about five years. Them screws is intended for adjustin' the pressure of the blocks agin the shaft an' is gen'ly made of brass. For small shafts like gate shafts it is common to line the bearin's with babbitt an' depend on the water fer lubrication."

"On vertical-shaft turbines how do they support the generator rotor and the heavy shafting, to say nothing of the runner? That stuff must be pretty heavy, Pop."

"Yep, it is. They most gen'ly uses roller bearin's, as engineers has been bit quite a few times on ball bearin's, prob'ly on account of the balls bein' too small, etc. In the early days it was quite common for balls to crush to a powder an' scratch up the ball races pretty bad before they could stop the generator unit. Some engineers prefers bearin's of the disk type an' they is some pretty fine bearin's of that kind, the Kingsbury style in partic'lar."

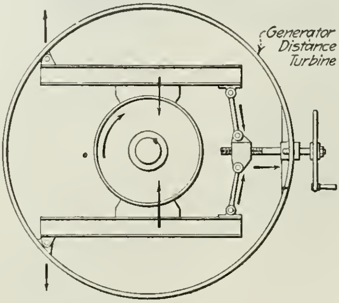
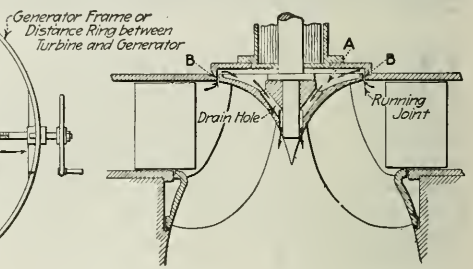


FIG. 5. TOGGLE-ACTION BRAKE


Generator Frame or Distance Ring between Turbine and Generator
A
B
B
Drain Hole
Running Joint
FIG. 6. DRAIN HOLES FOR CLEARANCE SPACE

"Have roller bearings ever gone to powder like the ball bearings you just spoke about?"

"Roller bearin's has squashed up kinda bad already, seemin' to freeze if not properly lubricated. That's one fault of disk bearin's as well."

"That makes me wonder how they stop those big units when they have to—real quick."

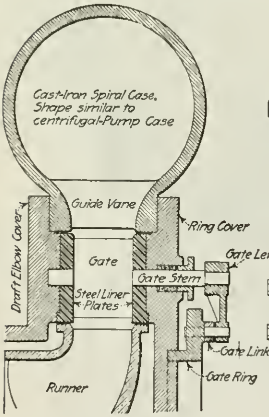


FIG. 3. SPIRAL CASE OUTSIDE ARRANGEMENT OF GATE REGULATION

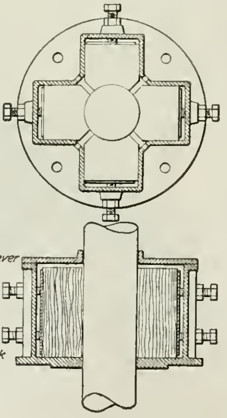


FIG. 4. APPLICATION OF LIGNUM VITÆ BLOCKS

"Brakes is usually furnished with such turbines, about like I shows in Fig. 5, consistin' essentially of two steel beams with brake faces bolted to them an' with some arrangement of toggle action to apply the pressure. On some units where the rotatin' masses ain't too great an' where the specified time for stoppin' ain't very short, some firms uses oak or maple blocks; but I considers wood to be dangerous, 'cause the brakes might seize for some reason or other an' then the thing takes fire. The usual time for stoppin' is from three to five minutes. If you jes' shut down the unit an' didn't apply the brake, the thing would prob'ly continue to run for fifteen or twenty minutes.

"They has been some attempt in Europe by Swiss and French engineers to use hydraulic brakes, the principle bein' of a paddle wheel keyed to the turbine shaft an' rotatin' in a closed vessel fulla water, an' under normal runnin' conditions the water bein' drained out. The paddle wheel is made of a sufficient number of plain disks, punched with a dozen or so of pretty big holes so that when not bringin' the unit to a stop they rotates in air an' don't do much fannin' 'cause the disks has no projections to fan the air with."

"That would do away with the tendency to heating up so much, wouldn't it? But there's somethin' else on my mind, Pop, left over from our last talk. Why did you show some holes in the runner hubs, and what are they for? Make me a sketch and tell me all about it," said Jimmy, eagerly.

"Oh, I know what you mean. Them holes is for drainin' the water out of the clearance space—the water that leaks in around the running joint. Jes' hand me that paper there to make you a drawin' on." Pop rapidly sketched Fig. 6. "That water, if allowed to remain there, would build up a pressure in the space *A*, 'cause it rotates with the runner, the same principle as the centrifugal pump, an' puttin' a whole lotta extra load on the thrust bearin'. In a runner of the type shown, the pressure would amount to about one-third the head in feet times the area inside the runner band at *B* if they was no drain holes there. With the holes the pressure is relieved about 20 per cent. The area of them holes should be about five times that of the runner clearance to do much good, an' even then some engineers insists on havin' drain pipes provided from this space to the draft tube to make sure that the pressure is relieved."

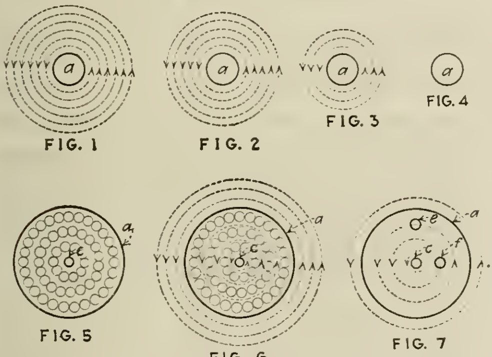
According to the *Electrical Review*, London, large schemes for the development of electric power, with high-tension transmission, are in progress or being worked out in the Dutch Colonies, one of which will develop 30,000 hp. There is undoubtedly a large future for all classes of electrical machinery in these sections. German competition has entirely ceased for the time being, and the natural source to obtain the machinery for these developments from will be Great Britain, America and Holland.

The Electrical Study Course—Properties of Alternating-Current Circuits

It is shown how inductance in an electric circuit is caused by the magnetic field set up about the conductors when current is flowing in the circuit. Hydraulic analogies are used to explain the effect.

WHEN a load is connected to a source of alternating voltage it is found that the value of the current that flows is dependent upon something besides the resistance of the load; namely, two other factors known as inductance and capacity.

Inductance is a property due to the magnetic field set up around a conductor whenever a current flows through it and the disappearance of the field when the flow of current ceases. Thus, let *a* in Fig. 1 represent the cross-section of a conductor in which current is assumed to be flowing up out of the surface of the paper. The magnetic field will surround the conductor as indicated by the dotted circles, and the direction of the field will be in a counterclockwise direction as shown by the arrow-heads. Suppose now, that the current is gradually decreased to zero. The field around the conductor will then decrease until it disappears, as illustrated in Figs. 2, 3, and 4.



FIGS. 1 TO 7. REPRESENTS THE ACTION OF THE MAGNETIC FIELD ABOUT A CONDUCTOR

The conductor *a* may be considered made up of many small conductors, as indicated in Fig. 5, and surrounded by a magnetic field when current flows through it. For example, the central conductor *c* would be surrounded by a field represented, in Fig. 6, by the dotted circles. If the current in the entire conductor be slowly decreased, the field around *c* will shrink, and as the lines of force contract they will cut across each of the other conductors. When conductors are cut by a magnetic field, an electromotive force is set up in them. In Fig. 6 the direction of the electromotive force would be up out of the surface of the paper. This will be understood from Fig. 7. The field cuts the conductor *e* from the upper side to the lower, which is equivalent to making the conductor move upward through the field. Applying the right-hand rule for the direction of voltage, it is found that the electromotive force developed is, as stated, out from the surface of the paper. Likewise the electromotive force in any other conductor, such as *f*, will be found to be also toward the reader. Consequently, when the field of *a* in Fig. 1 begins to shrink as in Fig. 2, an electromotive power is set up in *a* which is in the same direction as the current that is flowing through the conductor. Hence, the effect is a tendency to keep the current flowing.

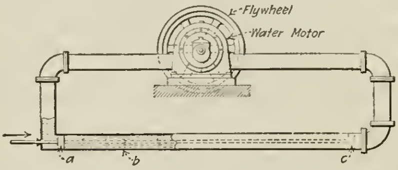


FIG. 8. HYDRAULIC ANALOGY OF INDUCTANCE

Suppose now, that after the current has been decreased to zero it is again gradually increased. Then the field will begin to expand, and it will therefore be moving in the opposite direction to that when it was decreasing. The electromotive force generated in *a* will then be in the opposite direction to that when the current was diminishing—namely, away from the reader—therefore will oppose the flow of the current and retard it. An expenditure of energy is required to produce this retarding force, and this energy is stored up in the revolving magnetic field. When the current decreases, the stored energy is given back, and it is the source of the force that tries to keep the current flowing, as described in the preceding paragraph.

This action of the magnetic field may be considered as a flywheel effect, such as would be obtained in a hydraulic system, similiar to that shown in Fig. 8, where piston *a* is arranged to move backward and forward in a long cylinder *b* the ends of which are connected through a water motor driving a heavy flywheel. When the piston is moved from left to right water will be caused to flow through the system and set the motor in motion. However, due to the inertia of the flywheel the motor will be slow in coming up to speed, and will offer considerable more resistance to the flow of the water than if the flywheel was used. When the motor reaches a constant speed corresponding to the flow of the water, the effect of the flywheel will be practically negligible and the water will flow through the motor at a rate equal to that as if the flywheel did not exist. However, when the piston approaches the end of the cylinder and begins to slow down, the fly-

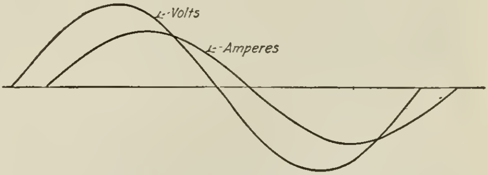


FIG. 9. CURVES SHOWING THE CURRENT LAGGING BEHIND THE VOLTS

wheel will keep the motor running and the latter will supply power to the piston to keep it moving to the right, just as the decaying magnetic field about a conductor will set up a voltage in the circuit to keep the current flowing when it is decreasing in value. It is evident, from Fig. 8, that the effect of the flywheel is to retard the flow of water when the latter is increasing in motion and to maintain the flow when it is decreasing in value. This is just the effect of the magnetic field on the flow of the current in the circuit, as pointed out in the foregoing. The result of the flywheel effect in an alternating-current is to cause the current to lag behind the volts, as shown in Fig. 9. In other words, the maximum value of the current occurs an instant later than the maximum value of the volts and the current reaches zero value an instant later than the volts.

In Fig. 1 the magnetic field constitutes the revolving flywheel that was set in motion in Fig. 8, when the current of water began to flow. When the current begins to decrease, this magnetic field gives up its energy and causes the current to continue to flow for a short space of time. If the flow of water in Fig. 8 is continued long enough for the pump to reach its normal speed, then, neglecting friction, as already pointed out, the water will flow through the motor almost as freely as if it were a piece of the pipe line. If, however, a rapidly reciprocating pressure is applied to the piston the flow of water cannot be very great, and no matter how often the operation be repeated, no great volume of water can be made to flow. Similiarly, in Figs. 1 and 4, if the voltage in *a* be increased and decreased rapidly, the flywheel effect of the magnetic field will retard the flow of current; the more rapid the changes the smaller will be the current that can be caused to flow for a given applied voltage. When the current is an alternating one, the changes are very rapid, consequently, if the flywheel effect is great, the current will be very small. This flywheel effect is called the inductance, or reactance, of the conductor. Since the reactance of a circuit causes a reduction in current, its effect is similar to that which would be caused by resistance. For this reason reactance is usually expressed in ohms, and is represented by the symbol *X*.

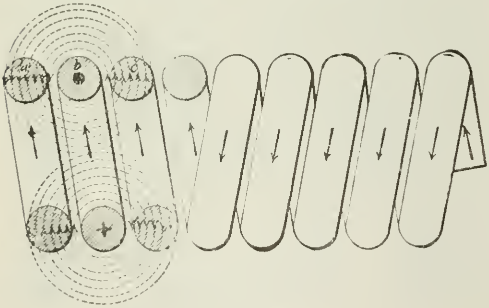


FIG. 10. REPRESENTS ACTION OF MAGNETIC FIELD IN A COIL

The reactance of a single straight conductor, such as *a* in Figs. 1 to 4, is very small. If, however, the conductor be wound into a coil, as illustrated in Fig. 10, its reactance will be greatly increased. The lines of force from a single section, such as *b*, will be cut by all the other sections, such as *a* and *c*, so that the total flux cut by the conductors will be greater than for a single conductor. If an iron core is inserted within the coil, the magnetic flux will be greatly increased thereby and the reactance will be correspondingly greater, since more flux is cut by the conductors.

If it were possible to have a circuit containing reactance only, we could find the current flowing through it from the formula $I = \frac{E}{X}$ just as in the case of resistance we use the form $I = \frac{E}{R}$. Thus in Fig. 11, let *X* be a reactance of 4 ohms and *E* be 120 volts, then $I = \frac{E}{X} = \frac{120}{4} = 30$ amperes. From this we might readily draw the conclusion that if we had a circuit such as that in Fig. 12, containing both reactance and resistance, as most all alternating-current circuits do, we could find the current by adding the reactance to the resistance and dividing into the voltage, thus: $I = \frac{E}{X + R}$, giving as a result $I = \frac{120}{4 + 3} = 17.1$ amperes. Such a conclusion, however, is not true; the current would have a value quite different from that so obtained.

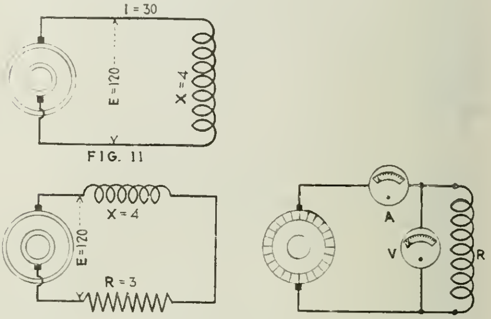


FIG. 11

FIG. 12

FIG. 13

FIGS. 11 TO 13. DIAGRAM OF ALTERNATING-CURRENT AND DIRECT-CURRENT CIRCUITS

Assume in Fig. 13 that a coil of wire *R* is connected across a direct-current circuit containing a voltmeter *V* and an ammeter *A*. If the voltmeter reading is 115 and the ammeter reading is 20. the resistance of the coil is $R = \frac{E}{I} = \frac{115}{20} = 5.75$ ohms. However, if this same coil is connected on a 115-volt alternating-current circuit, it will be found that less current will flow through it than on the direct-current circuit. Assume that the ammeter on the alternating-current circuit registered only 11.5 amperes. In this case the volts divided by the amperes would give what might be considered the apparent ohms, or, as it is called, the impedance of the circuit. Impedance is represented by the symbol *Z*. In the problem in question the impedance $Z = \frac{E}{I} = \frac{115}{11.5} = 10$ ohms.

In a direct-current circuit this would be 10 ohms resistance. However, on an alternating-current circuit it is made up of two factors: Ohmic resistance, which we found to be 5.75 ohms, when connected on a direct-current circuit, and a second factor—the reactance of the circuit. At first thought the conclusion might be arrived at that the impedance Z minus the resistance R would give the reactance in ohms; that is, $10 - 5.75 = 4.25$ ohms. However, this is not the case, as already pointed out. The reason for this is that in an alternating-current circuit the applied volts act as though they were divided into two parts at right angles to each other; one used to cause the current to flow through the resistance of the circuit, and the other to overcome the inductance; that is, the two have the same relation as the volts in a two-phase system. Consequently the resistance ohms and the reactive ohms must be considered 90 deg. apart. Where we know the resistance ohms R and the impedance ohms Z the reactive ohms $X = \sqrt{Z^2 - R^2}$. In this problem $X = \sqrt{10^2 - 5.75^2} = \sqrt{100 - 33.0625} = \sqrt{66.9375} = 8.18$ ohms.

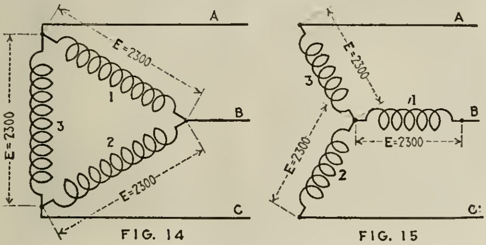


FIG. 14 FIG. 15

FIGS. 14 AND 15. DELTA-CONNECTED WINDINGS AND "Y"-CONNECTED WINDINGS

The voltage necessary to overcome the resistance of the alternating-current circuit is $E_R = I \times R = 11.5 \times 5.75 = 66.125$ volts, and the voltage required to overcome inductance is $E_X = IX = 11.5 \times 8.18 = 94.07$ volts. As stated in the foregoing, the voltage required to overcome resistance and that to overcome reactance act as though they were two separate voltages in the circuit 90 deg. apart as in a two-phase circuit. Consequently, to get the resultant volts E necessary to overcome the resistance and inductance of the circuit, add the component volts in a 90 deg. phase relation, or $E = \sqrt{E^2_R + E^2_X} = \sqrt{(66.125)^2 + (94.07)^2} = 115.02$ volts against 115, which we assumed the voltage of the circuit to be. In the next lesson the effect of reactance upon the power transmitted in a circuit will be considered.

One of the problems in the last lesson was to find the voltage per phase of a system connected to a three-phase generator having three separate windings each generating 2300 volts, if the windings are connected delta, also when connected in "Y." For delta connection the windings would be arranged as in Fig. 14. The voltage across AB would be that of winding No. 1, that across BC the voltage of coil 2, and that across AC the voltage of coil 3. Since the voltage of each winding is 2300 volts, the three voltages of the system would each be 2300 volts.

When the generator coils are connected "Y," as shown in Fig. 15, the voltage across AB will be the resultant voltages of coils Nos. 1 and 3 combined, which is equal to $2300 \times 1.73 = 3984$ volts. The voltage across BC is that of coils Nos. 1 and 2 combined, and that across AC of coils Nos. 2 and 3 combined, both of which give the same result as already found; namely, 3984 volts.

A third question was to compute the maximum value of an alternating voltage that indicates 220 volts on a voltmeter. The voltmeter reads the effective value of the voltage, and *the maximum value = effective value* $\div\ 0.707$, in this problem equals $220 \div 0.707 = 311$ volts.

Two hundred and forty amperes flows through a coil of wire when connected across a 120-volt direct-current circuit, but when connected on 210 volts alternating current 300 amperes passes through the coils. Find the ohmic resistance R, impedance Z, reactance X in the coil, volts necessary to overcome the resistance and the reactance volts.

Belt Selection and Installation

BY J. FRED ENGLER

When buying belting for any drive it is always well to bear in mind a thorough appreciation of the fact that the measure of the value of a belt is the efficient and satisfactory service it gives. The purchaser of a belt buys service. Service bears little relation to the initial cost. The belt that gives the most efficient and satisfactory service for the money invested is the most economical.

But since the value depends on service and service depends on so many factors, the selection of the best belt for any drive requires an intimate knowledge of the characteristics of each drive, of the belting available for it and of the integrity of the manufacturer of that belting.

The efficiency of transmission is measured by the load carried without slip or excess tension. This depends largely on the continuously efficient coefficient of friction. The friction coefficient of new belts is easily determined and has been established with a fair degree of accuracy for the various beltings in the market. But the frictional coefficient of new belts cannot be accepted as the continuously effective coefficient of friction.

Under clean conditions, with proper treatment the effectiveness of certain classes of belts increases with use; in others, under the same conditions, it decreases with more or less rapidity. Under usual mill conditions with dirt, dust, oil, steam, etc., the original frictional coefficient is soon destroyed or changed. The continuously effective coefficient of friction under actual working conditions can be determined only by close observation and regular and frequent tests.

Tensile strength, durability, pliability and resistance to atmospheric changes are important factors for consideration. Belting deficient in any of these essential qualities is neither efficient nor economical.

A belt should remain pliable to the last hour of service to secure that close pulley contact so essential to effective transmission. A stiff, hard belt has very little effective pulley contact without excessive tension. Some belting shrinks or stretches with every change of the barometer or may be breaking tight in the morning and so loose at noon that it fails in duty. Belts of this kind are expensive in lost production and lost power.

Most belt users are rather positive in their ideas regarding the kind of belting they think is best adapted to their work. If these ideas are the result of numerous actual tests, they are well founded and sound, but if they are reached through guesswork, tradition and prejudice, they may be mighty expensive. Most makers of good belting are more anxious to have their best belt used for a drive that will stand for service than to simply sell a belt. Belting that is sold on a service basis is a safe investment.

Before placing a belt see that the shafting and pulleys are in alignment and that the pulleys are well balanced as to both relative and individual size. Endless belts run smoothly and give satisfactory service provided the lacing is properly done and the belts are closely watched while in service.

It is a mistake to punch lace holes. A belt awl should be used to force the fabric apart, retaining as much of the original belt strength as possible. Belts generally fracture at the lace holes. There is a general tendency to use a large lacing. The strength of a laced joint increases as the number of lace holes increases and the size of the holes decreases. A swing joint gives the best transmission on small pulleys.

Of the numerous metal fasteners on the market those that penetrate without cutting the belt and leave the least exposed metal on the pulley side of the belt are the most desirable. In applying a metal fastener care should be taken so as not to start a fracture either in the belt or the fastener.

Having used every effort to select the best belt for the drive and install it properly, keep a record of its performance consisting of the average horsepower transmitted, the slip, the tension, the time lost for repairs, the repair cost and the length of service, with remarks on causes of failure and any item of interest relative to belt transmission. This is the only way in which a detailed knowledge of transmission costs can be secured. This knowledge, aside from being a matter of satisfaction, will be a potent factor in rectifying many mistaken ideas regarding belt transmission and in the reduction of transmission costs. Where such records are kept, there is no market for inefficient belting at any price.

Nugent Automatic-Alarm Oil Filter

A dirty oil filter is a useless device. As the filtering bags fill up with accumulations of sediment and dirt, the capacity of the filter gradually diminishes until its output of cleansed oil is far below the rate of dirty-oil inflow and the filter becomes flooded and overflows or the supply of freshened oil to the lubricated parts becomes less than the requirements.

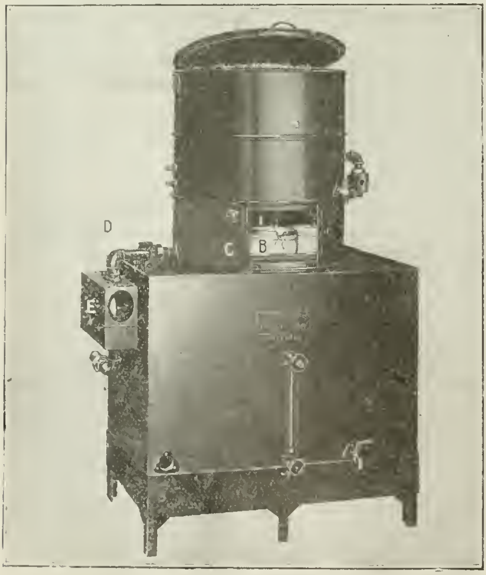


FIG. 1. NUGENT AUTOMATIC-ALARM OIL FILTER

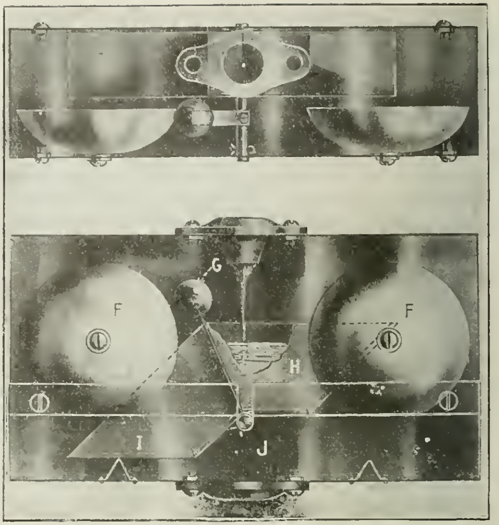


FIG. 2 DETAILS OF DIRTY-OIL ALARM MECHANISM

Hitherto the only way in which to forestall such trouble was to make periodic inspections. If inspections were forgotten or if the accumulations of sediment and dirt became unexpectedly rapid, trouble developed anyhow. With the purpose of doing away with this danger, W. W. Nugent & Co., 150 West Superior St., Chicago, Ill., have developed an automatic-alarm filter. The filter, Fig. 1, is the standard apparatus put out by this concern and was described in *Power* for Jan. 1, 1918. The automatic-alarm feature is shown at *E* and a detail in Fig. 2. The dirty oil from the receiving chamber *A* feeds into the standard triple filtering bags as shown. The holding rings of these bags are made with an overflow spout, shown at *B*, which discharges into the trough *C*. This trough connects with the outlet pipe *D*, which in turn discharges into the alarm box *E*.

Referring to Fig 2, the alarm mechanism consists of a tilting two-compartment tank hinged at *J*, two gongs at *FF* and a beater *G* which moves with the tank. When the compartment *H* fills to a given level, the tank becomes overbalanced and tilts to the right, whereupon the beater comes in smart contact with the right-hand gong *F*, sounding the alarm. The overflowing oil then discharges into compartment *I* until it in turn becomes overbalanced and sounds a second alarm upon the left-hand gong *F*. This cycle is repeated until the needed attention is given the filter and the bags cleaned.

When one bag only is overflowing, the interval between alarm signals may be, say, one minute. When the second and third bags begin to overflow, the interval between alarm signals becomes shorter and the alarm more insistent.

By a simple modification the alarm box can be connected with electrical mechanism so that a buzzer or bell located anywhere about the plant can be sounded to give warning. Or, if desired, a light can be flashed to serve the same purpose.

EDITORIALS

Operating Engineers of the Future

THE development which steam power has passed through has brought about radical changes not only in plant equipment, but also in the duties of the steam engineer. The early power plant was what might be termed a steam-mechanical outfit. The plants for the most part were so small that the engineer was usually the fireman, oiler, engineer and mechanic combined. If this individual of many jobs was a good mechanic with a stout arm and a willingness to work hard, he generally proved to be what was considered a good engineer. If he lacked in these qualifications, the plant and equipment suffered accordingly. Fuel was cheap and it was of little concern to the management whether a horse-power hour was produced on five pounds of coal or twenty—the one thing of prime importance was to keep the plant running. Even though this engineer might have wished to operate his plant in an efficient manner, there were few devices available to afford him an intelligent understanding of the actual conditions in the boiler and engine room.

Approximately one hundred years after Watt succeeded in making the steam engine applicable to the driving of all kinds of machinery, the first commercial electrical generator was put into service. This epoch-making event may be considered the beginning of the economical generation and transmission of power, and with it the operating engineer's profession began to take on a new aspect. By the use of the voltmeter and an ammeter it was possible to ascertain the load on the station at any time. This soon created an incentive to know what was required to produce this load, and then there gradually followed a development of boiler-room instruments which now form a part of every up-to-date plant.

In addition to the electrical equipment the engineer is often in responsible charge of heating and ventilating apparatus, refrigerating equipment, air compressors, etc., all of which may be driven by steam engines, steam turbines or electric motors. To meet these added responsibilities he has found it necessary to broaden his knowledge and develop his executive ability.

In considering the super-power systems, which are being talked about so much, the operating engineer may be led to question his future and to ask what he can do to prepare himself to meet the new conditions. The best answer is to acquire a broader knowledge of things electrical. Where pumps, compressors, etc., are now driven by steam, in the future they will be driven electrically, but they will always require the same intelligent care and even more than the steam-driven equipment. The need for economy in keeping down power consumption will be just as great as with steam equipment. Instead of these problems characteristic of the steam equipment, there will be load adjustment to keep the maximum demand to a minimum, adjustment of the power factor, etc., all of which call for intelligent handling.

The Busy Season in the Power Plant Begins

THE fall and winter seasons, with their short, cold days and nights, mean much to power-plant men. The electric-lighting load and heating load increase throughout the twenty-four hours of each day. The equipment should be ready for it.

For refrigerating plants these seasons bring relief, as the load in nearly every plant drops enough with the coming of cool weather to permit of shutting down part of the station to make necessary repairs, cleanings and inspections. Now is the time to be ready to renew badly worn parts, rebore compressor cylinders, clean condensers and evaporating coils, and renew or grind in leaky valves.

While the plant is down or partly down for such work, the time is opportune to make such changes in piping and connections as experience throughout the season or over the years has shown necessary or desirable. The engineer who has this work laid out to be done in convenient sequence and according to a schedule is a man with foresight. Too often, work of this kind is thought about a great deal, yet when the time comes when it should be done, the crew or the chief engineer of the plant is unprepared, and without good reason.

We have in mind a large hydro-electric station where there are many main units and where the station load is high and continuous. Inspections and maintenance work are done according to schedule. A chart having rectangles representing every piece of apparatus or large parts of machines, such, for example, as main unit governors, is hung in the chief operator's office; the chart covers a period of one year. As each inspection and repair or renewal is made, the rectangle representing the part or machine is filled in with colored ink. A fully inked-in rectangle signifies a completed job. If the job is but half finished, the rectangle is but half colored. The inspection and maintenance charts, together with the yearly work schedule, insure not only that the work goes on smoothly and on time, but that no vital part is overlooked. While such provisions are too elaborate for the small plant, their success demonstrates that more intelligent planning of inspections, repairs and maintenance in small plants would avoid many of the breakdowns and emergencies that occur to them. Now is the time for the refrigerating engineer to complete his plans and schedules for the low-load winter season.

Presumably, every man responsible for a steam-heating system has taken advantage of the summer and now has everything ready for the load so soon to come. Radiator-valve stems should be packed, also the pumps; additional radiating surface should now be ready for use in rooms where too little surface brings discomfort to occupants and annoyance to the engineer. Air valves, invariably a source of aggravation, should by now have been overhauled. These are but a few of the details about a heating system, which must function well if the service is to be a credit to the engineer in charge.

Generally speaking, for all but refrigerating plants, the engineer who has not taken advantage of the warm, low-load season to put his plant in the best possible condition for the season's run will likely have reason to regret it before the winter season is over.

Power-Supply Problems

CONFRONTED by a threatened fuel shortage due to decreased production, with the consequent necessity of eliminating inefficiency in the power supply, the British government has recently sponsored an "Electricity Supply Bill." This aims to place the whole matter in the hands of a commission which, acting through district boards, would control all the electric systems throughout England. As originally drawn the bill contained many drastic features, but later amendments aim to coördinate rather than eliminate many of the existing systems and would tend to conserve the experience of those who have been intimately associated with these systems rather than place them in the hands of political appointees.

This recognition on the part of the British government, of the vital importance of cheap and adequate power as fundamental to healthy industrial progress, recalls the attempt last winter of Secretary Lane to secure an appropriation for a power survey in this country. Although the proposal had the unqualified support of the engineering profession, it failed to sufficiently impress Congress and suffered the fate of the water-power and other well-merited bills in the filibuster that occupied the closing days of the session.

The Secretary evidently recognizes the futility of having the bill reintroduced at the present time, but the subject is too important to be set aside and warrants immediate consideration as soon as Congress has disposed of its present foreign-relations problems. But it will receive consideration only in proportion to the active support given it by engineers in general.

Who Is Responsible?

FOR months past there has been standing idle at Muscle Shoals, Alabama, a sixty-thousand kilowatt power plant complete in every respect and representing the best practice that skilled engineers could lay down. This installation forms part of the great nitrate plant that was to turn out nitrates by the ton for our vast explosives program, and was described in our March twenty-fifth issue.

The armistice came before the plant got into production, although the construction was carried to completion, the big turbo-generator turned over and then, after a short time, the operating crew departed and watchmen were placed in charge.

This plant was designed for the production of nitrates by the cyanamid process, and it is claimed that, with slight additional expenditure, it could be converted for the production of fertilizer for which the farmer is now required to pay such exorbitant prices. This is aside from the enormous idle investment represented.

Who is responsible? Is it the War Department or is it Congress, or, perchance, just Government inertia? It has been said that the Government has not the talent to operate the plant and is unwilling to turn it over at the figure offered by the company that would have operated it had the war continued. In any event, to have this costly equipment idle is a large and needless economic waste.

In a paper on "The Isolated-Plant Costs, as Influenced by the War," presented at the twelfth annual convention of the Pennsylvania Electric Association, this statement is made: "A study of a number of isolated-plant cases developed the fact during the year of 1919 we (central stations) would have been required to reduce rates 22.1 per cent. to secure the business of the cases studied, whereas in 1918 we could have increased our rates 46.9 per cent." Apparently, this is an admission that the cost of central-station service could not meet that of many isolated plants until after 1916 and no doubt accounts for the fact that so many of the latter withstood the efforts of the former, prior to this time, to shut them down on sound economic principles.

In a recent address M. O. Leighton, chairman of the National Service Committee, ascribed much of the inefficiency in Government departments to the enlargement of Federal activities without regard to their proper coördination. The result is that numerous bureaus, whose work is of an engineering character, are attempting to function within departments that have little or no relation to the work in hand, and the heads of these departments are frequently required to pass upon matters of a technical nature. The bill now before Congress providing for the creation of a Department of Public Works aims to remove these misplaced bureaus and place them all within the one department, which would be organized on engineering lines.

During the first week of October Harvard graduates will undertake a nation-wide drive to secure an eleven million dollar unrestricted endowment for the university. It is the intention to devote a large share of the income from this endowment to increasing the salaries of the professors and instructors. The present scale, although comparable with those of other large universities, is so low as to make it difficult to hold the teaching organization together. This condition is typical, and because the incomes of the universities have not kept pace with the expenditures, the relief is necessarily in the hands of the alumni. Others might well emulate the example of the Harvard alumni.

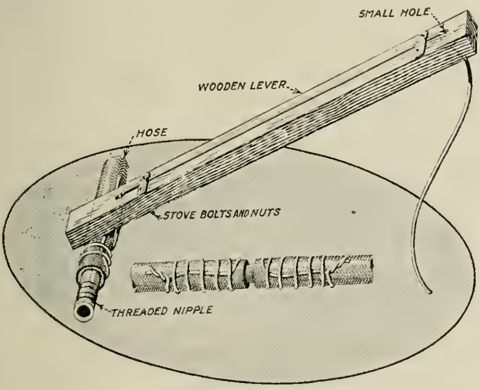
Under the caption of "An Editor's Ignorance" the *Black Diamond* takes issue with our editorial of July twenty-second, on the coal situation. We frankly admit ignorance of much that goes on within the inner circles of the coal industry; if we knew more it would make very interesting reading for the large number of consumers that we reach weekly.

American engineers have become accustomed to a steady increase in transmission-line voltages, but the jump from 150,000 to 220,000 volts in California is a step that does credit both to the boldness of the promoters and the skill of the designers.

Correspondence

Repairing Hose Leaks

In a certain plant they have a neat and effective method of repairing leaks in steam or water hose. They use a hardwood lever about 2 x 2 x 15 in. long with a $\frac{1}{4}$-in. hole bored through it at each end, as shown in the illustration. Then about a No. 14 wire is put through these holes and held in place by two metal clips that are attached to the lever by stove bolts and nuts; these hold the wire taut or loose as desired.



TOOL FOR WIRING HOSE JOINT

The hose to be repaired is cut, at the leak, and a threaded nipple of the correct diameter is inserted in the hose. Then with the aid of a vise and a pair of pliers a neat joint can be made by using the lever as shown.

J. A. Landolina.

Memphis, Tenn.

Packing Cage Sections Gripped Packing Rings

I once took charge of some large double-acting gas engines, and beside numerous other difficulties, I found that the operating force had been and were having trouble with the water-cooled piston rods running hot at the point where they worked through the packing cages.

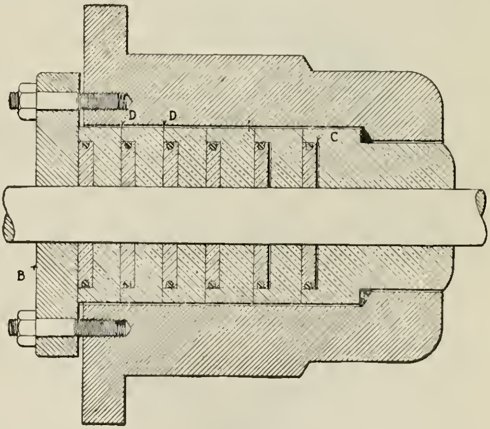
This statement may sound exaggerated, but I stood on the switchboard gallery and saw one of those rods with a place on it as big as my hand, red hot, and when they got in that condition, there was nothing to it but to pull them off, run slowly a while until the rod cooled down, stop, pull out the packing cage, file the rod smooth (if it wasn't warped so bad as to be beyond any further use), put in new packing and try again.

The practice had been to pull the packing cage out on the rod, take the sections of the cage apart, hook the new garter spring around the rod, assemble the sectional packing ring between the spring and the rod, slide the next section against it, put in the No. 2 ring, and the next packing cage section against it, and so on until all the rings and sections were assembled.

The illustration shows the construction of the packing cage. There were four long studs (not all shown), which screwed into the flange bottom, passed back through all the sections and the flange *B* with nuts on the outer ends to hold the sections together. It was noticed when the repair men were putting the cages back in place that if the four nuts were pulled up tight the cage was hard to push on the rod, and an investigation was immediately started.

It developed that the sections had been ground together so much that the width of the ring recesses had been so reduced that it was narrower than the ring was wide, thus following the ring to be clamped between the sections, as shown at *D, D*.

No stuffing-box could be expected to work this way, and as there were several old cages around the plant, the sections were taken from these, put in the lathe, and the ring recesses deepened so that the packing ring had about $\frac{1}{64}$-in. side clearance as shown at *C* in the figure.



PACKING RINGS PINCHED IN PACKING CAGE

After this, the packing cages were assembled on the floor with the rings in place and care taken that the rings were free to move after the nuts on the long studs had been pulled down as tight as they could be pulled. It is needless to say that we had no more hot rods from this cause.

Earl Pagett.

Cherryvale, Kan.

Influence of Air Density on the Pneumatic Type Steam-Turbine Governor

Referring to the type of steam-turbine governor, described on page 300 of the Aug. 19 issue of *Power*, it will be evident that a change in density of the air due to changing atmospheric conditions within the turbine room may cause a slight change in speed of the turbine. This, however, in practice is found to be negligible. For a better understanding of this condition, refer to the accompanying chart, which shows the change in density of the air due to a change in temperature, humidity or barometric pressure.

The temperature line is based on a barometer of 30 in. and a relative humidity of 65 per cent. which is approximate for this investigation; any other basis would simply show a parallel line. The humidity line is based on a barometer of 30 in. and a temperature of 75 deg. F.; any other basis would give a parallel line. The atmospheric pressure or barometer line is based on a temperature of 75 deg. F. and a relative humidity of 65 per cent.; any other basis will give a parallel line.

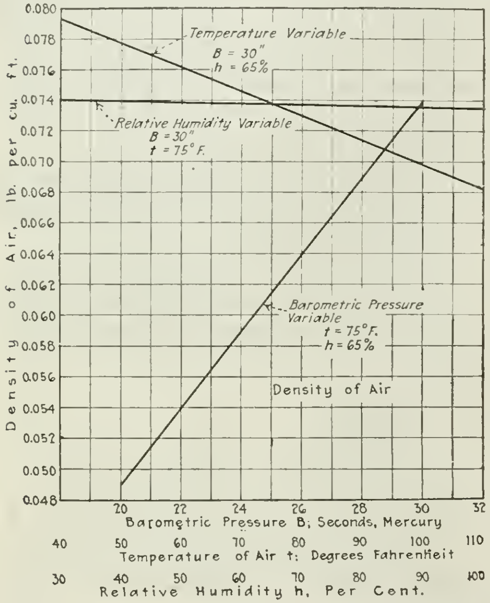


CHART SHOWING CHANGE IN DENSITY OF AIR DUE TO CHANGE IN TEMPERATURE, HUMIDITY OR BAROMETRIC PRESSURE

The change in density of the air may be read from the vertical scale for a change of any one of these properties of the air, viz., barometer, temperature, or relative humidity. In the operation of such a governor, the air pressure generated by the fan is proportional to the density of the air and to the square of the speed

A change in barometer reading of say 1 in. from 28 to 29 in. (which is considerable and would be over several hours' time), would mean a difference in density of about 0.0024 lb., per cu.ft., that is a change in density of about 3.47 per cent. Since the pressure change is as the square of the speed, by extracting the square root of 3.47 we have 1.8 per cent change of speed. With the provision for speed adjustment this is easily taken care of. Furthermore, as stated, a 1-in. change of barometer is about the extreme range of change in most localities and this rarely occurs except over 24 hours or more of time.

The humidity line shows there is so little change in density, due to any possible change in humidity, that it is negligible.

A change of temperature in the engine room of from say 80 to 100 deg. F. will cause a difference in density of 4 per cent., the square root of which is 2 per cent possible change of speed. Such a change in temperature rarely occurs in an engine room and can easily be adjusted for if necessary, as it will always be over a considerable period of time, and is therefore unimportant. Only the make-up leakage of air past the pistons requires to be replaced by the fan, and in fact with this construction it is possible to return the leakage air to the suction of the fan, or to conduct the air from a point not subject to considerable variation, to the intake of the fan.

Actual service shows that any change in air conditions which occurs in an engine room has no effect of any consequence on the operation of these governors. The figures taken for illustration are extreme, and therefore not applicable under normal conditions.

THOMAS HALL,
Mechanical Engineer, Ridgway Dynamo & Engine Co.
Ridgway, Penn.

From a Woman Chemist

I read with interest an article in your issue of Aug. 26, page 332, entitled, "Coal Analyses made at the Power Plant," and especially the introductory statement, which reads: "A method which obviates the necessity for sending coal to a chemist and gives accurate results promptly. The work can be done by a woman and apparatus costing $300."

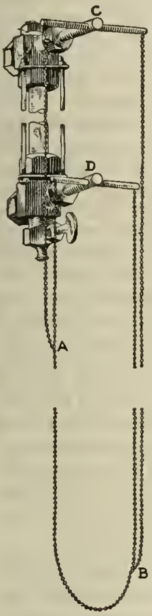
Being a woman and in charge of the research laboratory of a paper mill, I am especially interested in the line of reasoning by which you or the author of the article arrived at the estimate of women implied in the quotation. Perhaps you might be interested to know that there were three years ago fifty women registered as having received Ph.D. degrees in chemistry in the United States and that there is a large army of them with B.S. and M.A. degrees, and various practical experiences whose proven skill would justify their resentment of the foregoing statement.

In employing the partly trained help, I much prefer women because they more quickly arrive at an understanding of the problem back of the test and the more easily become efficient chemists with an ample supply of general information on the engineering side of the industrial chemist's position. Indeed, whenever we have had coal samples to test here, we have given the work to a girl chemist, because we have not yet installed a calorimeter and the girls more easily learned the more difficult combustion analysis.

Altogether, my experience and knowledge would lead me to resent the implication in the sentence quoted, I should be interested to know whether your experience does justify it, or whether the sentence slipped through by mere accident. JESSIE E. MINOR.
Garfield, N. J.

Chain Arrangement for Gage-Glass Cocks

I would like to suggest a method of installing chains on the quick-closing valves of water columns that I have found of advantage in keeping the glass in working order. Although these valves are installed primarily for the purpose of shutting off the boiler pressure while renewing the water glass, they can be easily made to assist in keeping themselves clear and free from obstructions.



CHAIN CONNECTIONS

Referring to the sketch, connect a chain to each end of the lower lever *D* as is usually done. Then instead of connecting the arms *C* and *D* by short chains direct, connect the left or opening side of the top lever *C* to the chain from the lever *D* at a point *A*, about 12 in. below the lever *D*. Connect the chain from the right, or closing side of lever *C* to the chain from the lever *D* near the bottom of the loop, as at *B*, within easy reach of the operator.

The idea is this: The upper cock *C* contains steam and the lower cock *D* water; incidentally the top cock seldom gets stopped up, whereas scale, etc., in the water frequently stop up the bottom cock. Now, in case of a stoppage of the lower cock for example, it is only necessary to close the top cock by means of its individual chain, and with full boiler pressure behind it almost any obstruction in the bottom cock can be blown out by opening the usual column blowdown valve or cock.

In blowing down a water glass with both top and bottom quick-closing valves open the steam flows through the upper valve and tends to balance the pressure on the lower valve, consequently the effective pressure tending to blow obstructions out of the lower glass is quite low.

I have found that the ordinary obstruction in either valve can be easily removed by closing the opposite valve and blowing down the glass, whereas it would not respond to the ordinary method of blowing down the column with both top and bottom connections open at the same time.

Water columns, as a rule, have a tendency to stop up, probably because the radiation from them cools the water contained and precipitates some scale. Then also the openings to the glass itself are small and a piece of scale or rubber gasket will shut off the circulation, especially in the lower connection.

Where no valves are provided in the water-column connections to the boiler, this method of connecting the chains will be found extremely useful. Many engineers are opposed to valves in such connections, and have good reason to be, because of the careless method employed in handling boilers by some firemen. In a case of stoppage and no valve in the connection it is necessary to cut the boiler out of service and relieve it of all pressure, before the column can be examined. The suggested method of connecting the chains to the quick closing valves will reduce this trouble to a minimum.

New York City. WARREN D. LEWIS.

Was Caustic Soda Responsible?

A noncritical or hasty reading of the article entitled "Rear Head of Steam Drum Fails," on page 70 of the issue of July 8, and the editorial entitled "Was Caustic Soda Responsible?" on page 71, might leave the impression that this accident was due to the presence of caustic soda in the boiler water.

We have collected considerable information on this subject, and there appears to be a probability that a high concentration of caustic soda may embrittle steel plates under certain conditions, as for example, steel tanks or drums in which caustic soda is concentrated or stored. But the evidence so far collected does not seem to be conclusive nor does it prove that cencentration of caustic soda such as would occur in water treated by the usual softening methods would be harmful.

Finally, according to your own statement in the last paragraph of the editorial, you have no evidence that the water used in the Newmarket boiler contained caustic soda, so why intimate that this was the cause of the explosion? G. H. GARRISON.

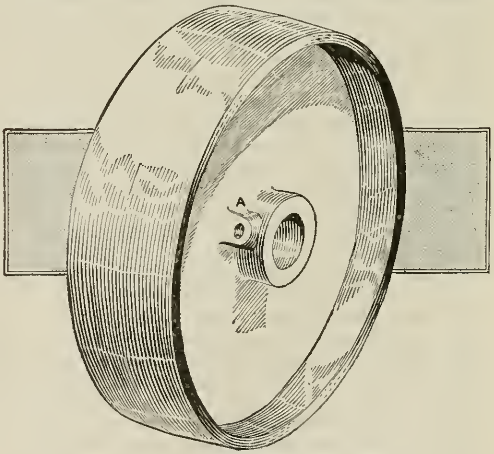
New York.

[The boiler in proximity to the leak was covered with a white deposit, and the fracture was such as has characterized previous failures traceable to this cause. —Editor.]

Small Pulley Setscrews

Small cast-iron pulleys are usually screwed to the shaft by means of a setscrew through the hub. After short usage the threads usually strip and frequently the hub will split, rendering the pulley useless.

Before having such a pulley cast, it would be easy to attach a boss to the pattern as shown at *A* to give a greater length of thread and to prevent the hub splitting. Care must be taken to allow room to insert the screw between top of boss and rim, unless a headless screw is used and inserted through a hole in rim.



PULLEY WITH SETSCREW BOSS

If the pulley runs at such a high speed that a boss on one side would cause vibration, two opposite bosses could be cast on to balance each other.

Oakland, Calif. H. H. PARKER.

Pulverized Fuel for the Railways

My attention has been called to an article in the June 24 issue of *Power*, under the title "Pulverized Fuel for the Railways," the same being an abstract and comment on the report of the committee on pulverized fuel which was presented at the International Railway Fuel Association meeting in Chicago during the week of May 19.

There are a few things in this report upon which I believe a little more authentic or reliable information could be presented, in view of the fact that among the reports quoted there was such a wide difference of opinion and of results obtained.

In regard to the information from the third source, it mentions that "the only difficulties were with the drying, pulverizing and handling of the coal and also the danger in connection with it." The only reason we can see for mentioning these items as difficulties is that the committee that made this report either had a very poorly designed and equipped pulverizing plant for their model or else their source of information is rather limited in so far as the burning of pulverized coal in locomotives is concerned. The drying, pulverizing and handling of the coal is no more difficult than at the present time with hand-fired locomotives, and in fact less actual manual labor is required from the time the coal is dumped from the cars until the time it is loaded in the locomotive tender, and it is common practice in large pulverized coal plants to run the drying and pulverizing equipment 20 to 24 hours a day.

As all the coal which passes through the pulverizing plant is crushed down to uniform size before being pulverized, it is evident that no trouble or stoppages can occur in the transporting system due to large lumps, etc. Again, as the coal, after being pulverized, is passed directly into water-tight and air-tight storage bins, there can be no trouble whatever from moisture in damp weather or freezing in winter weather, and it is then as easy to coal the locomotive tender as it is to fill the water tank, as this is done through a canvas spout.

Notation is made of the old time-worn expression of the "danger in connection with it." Years of experience of those familiar with its use prove conclusively that pulverized coal, when properly handled, is no more dangerous than lump coal, either on locomotives or anywhere else, and in some respects it is even less troublesome or dangerous than lump coal. As a matter of interest it might be noted here that we have in more than one instance loaded pulverized coal which was afire from a storage bin into a locomotive tender. This coal was smoldering or burning so rapidly that you could not see inside the tank on account of the smoke after loading the coal therein. After the coal was loaded in the tender the top of the tank was simply closed up tight and within a few hours the CO_2 generated entirely extinguished the fire and no trace of it could be found, and the coal could then be burned in the regular manner. In fact it can be burned immediately after placing in the bin while still afire if so desired, and we have often done so with no trouble whatever.

In regard to the paragraph which says "the tendency of explosion and spontaneous combustion which is always present in coal of this character should be eliminated entirely if possible to do so." In reply to this it can be stated absolutely that the tendency of explosions have been practically eliminated in modern plants such as now designed and built, and in so far as the coal carried on a locomotive is concerned this is entirely harmless as it is carried in bulk in an air-tight tank, and therefore there is no tendency for dust to rise and blow around where it could be ignited. In regard to the elimination of spontaneous combustion it is a fact that we have never known this to occur in a locomotive tank no matter how long the coal had been stored, and it can also be prevented in storage tanks by simply making sure that they are air-tight, as the coal will not burn without sufficient oxygen.

We fail to see how any specially designed furnace, especially on a locomotive, could be constructed which could burn coal ground to the fineness of granulated sugar in suspension. An instant's thought will show that this is rather an impossible supposition when the fact is taken into consideration that the air passing through a locomotive firebox travels at such a high velocity that the entire contents of the firebox are replaced in from four to six times a second, and coal pulverized to the fineness of granulated sugar unless it were gunpowder or something similar would certainly be deposited against the flash wall or in the bottom of the combustion chamber before it would be half consumed, and it of course would then only be a matter of a short time before the whole firebox was filled up. The only way it could be kept in suspension in a firebox such as on a locomotive, would be to carry such a terrific draft that it would be carried over the arch and through the flues before it would be half consumed, and of course then the efficiency would be nil.

In regard to pulverizing coal on tenders of locomotives, this would certainly be a very undesirable feature in our opinion, as the apparatus necessary for pulverizing coal to the proper fineness must be quite heavy and strongly constructed, and the space and weight it would occupy on the tender would be out of all proportion to the work done. Certainly nothing is more simple than to run a locomotive under a tank or bin of ready pulverized coal as at present, open a valve, and in a few minutes have a tank of perfectly dry pulverized coal. It is as simple as filling a tank with water.

It certainly is not the intention of the railroads if they adopt pulverized coal to have it prepared at a central pulverizing plant and have it transported to other parts of the system for use, any more than it is for the railroads to have coal bunkers at one point and then transport the coal in cars hundreds of miles where they have no bunkers to coal locomotives for hand-fired use. There would have to be pulverizing equipment at each large coaling terminal.

There is one objection which the committee have not noted in regard to conducting experiments at the test plants of large universities with pulverized-coal fired locomotives; that is, that in running over the road the coal in the tank of a tender becomes quite firmly packed from the constant pounding and vibration. This brings up a condition in regard to feeding which could be hardly duplicated at a test plant, as one of the essential features of a pulverized-coal burning equipment on locomotives is that there must be a constant steady feed to the firebox at all times, for as there is hardly more than a pound of coal in the firebox at any instant it can be readily seen that the least interference with steady feeding would very quickly affect the steam pressure and steaming qualities of the locomotive. In other words, apparatus which worked out very nicely on a locomotive when standing still or around the yards, proved to be wanting in a good many things when it was taken out on the road, due mainly to the action resulting from the packing of the coal in the tender.

In regard to the matter of "not enough having been said about cash balances but only fuel economy," the main trouble here is that on all the railroads where experiments with pulverized coal have been conducted, only comparatively small pulverizing plants have been used and naturally cash balances cannot be offered in this case as evidence, as the cost of pulverizing the coal does not approach an interesting figure until large amounts are pulverized in commercial plants, such as from 100 to 1000 tons daily. These cash balances can be obtained, however, on absolutely reliable and authentic records from any number of plants which have been pulverizing coal daily for many years and in which correct records are kept of everything, including power, labor, depreciation, etc., from the time the coal is dumped from the cars until the time it is burned in the furnaces or boilers. For instance, pulverized coal can be prepared today in a thousand-ton-capacity plant for 36 cents per net ton. This cost includes power, labor, depreciation, interest, taxes and insurance, these based on the following figures:

Power at ¾ cents per kw.-hr. and allowing 13 kw.-hr. per net ton pulverized; labor at 40 cents per hour; coal for the drier at $5 per net ton delivered; repairs at 7 cents per net ton pulverized; interest at 6 per cent.; depreciation at 4 cents per net ton; taxes and insurance at 1.3 cents per net ton, making a total of 36 cents per net ton.

These figures are based on standard practice today in the average large coal pulverizing plant and would, of course, vary somewhat with local conditions, cost of labor, power, etc.

W. D. Wood,
Locomotive Department, Fuller Engineering Co.
Allentown, Penn.

Low Pay of Government Technical Men

Recently, an article appeared in the technical press about the low pay of technical men in the Bureau of Standards, this pay being so low that a great many of the men had to resign and seek employment with private concerns.

From experience, if the Bureau of Standards pays its technical engineers any less than the Navy Department pays its men of the same ability, there is no formula by which both ends may be figured to meet and live. The Navy Department has lost, is losing and will continue to lose its best technical men on account of low pay, and I wish to say here, that the Navy Department has not considered the fact that it must pay the same salaries as private concerns if it wants to keep efficient men.

The Navy Department seems to think its technical men can live on promises, as it has promised to look into the matter of readjustment of wages of technical men—this in December, 1918, but up to July, 1919, no relief had come. If it takes this long to look into the matter, it will probably take several years to force itself to actually do anything in giving justice to the men in the department.

Now the technical forces have organized and affiliated with the American Association of Engineers, and let us hope that the A. A. E. will grow and raise the standard of engineers, as most every trade and profession has a standard, and if an employer does not meet the standard he will have to take the second rates.

There are engineers (civilian) working in these yards who command, outside, from $3000 to $7000 per year, but they worked for the Navy on account of the war for wages of from $5 to $8 per day, not even on a monthly basis, but per diem, like a laborer, and it stands to reason that these men cannot see their way clear to remain with the Navy Department.

It costs the Government about twice as much to do a thing as it does a well-managed private concern. Why? The answer is inefficiency, and inefficiency is in evidence at every turn in the navy yards. This could be remedied if the Government would take a few lessons from some of our large manufacturing concerns.

To show some of the Government inefficiency, Washington orders the various yards and stations to do certain minor things, which are not the proper things to do, but if any initiative is shown by the yard, and especially by civilian engineers, it is promptly sat upon at Washington. Washington does not allow each yard to handle these minor details as best suited for each and best known by each respective yard.

Norfolk, Va. A. W. Koiner.

Peening Stopped Leak

On page 233 of the Aug. 5 issue, A. Dolphin tells of stopping a leak in a 12-in. steam nozzle by peening. At one time I had three boilers working under 125 lb. pressure and a leak showed up on the steam nozzle at the threads. On examination it was found that the pipe was properly screwed into it. A ball-peen hammer was put to work on the inside, peening it out; the result was a permanent job and the leak was stopped. At another time the nipple to the safety valve began leaking at the threads. The piping was extra-heavy and this leak was peened out.

I have often stopped leaks around the threads in headers, and steam-pipe lines at the flanges by peening. I always make a tight job, although one should be careful not to peen too heavy as it will sometimes crack a flange, but in boiler nozzles it makes no difference.

Columbus, Ohio. L. A. Cowles.

Blowing Down Boilers

In reading Mr. Molloy's description of his practice in blowing down boilers, page 657 of the Apr. 29 issue, it was not clear to me why he blows down. The reason I blow down is to get rid of some of the dirty water or of the dirt in the water.

In order to do this I blow down when the fires are active, whether the pressure is high or low, but preferably low. When the fires are active the dirt in the boilers is mixed with the water; when the fires are dead the impurities settle out of the water and will be found on the tubes, the bottom of the boiler and on any projecting parts. When the fires are active the impurities are mixed with the water; when the fires are dead only a small amount of mud lying close to the blowoff will be removed.

R. McLaren.
Toronto, Ont., Canada

Water-Column Blowoff Valves

On page 27, of the July 1 issue, R. A. Cultra favors gate valves as being better than globe valves for water-column blowoff connections. If the bottom connecting pipe fills with scale, the plug in the cross fitting below the column can be removed and a rod run through the pipe to clear it when a gate valve is used; it cannot be done with a globe valve in the piping.

If pipe of the proper size is connected to the water-columns, say 1 or 1¼ in., there is little chance of even a globe valve closing up. The top connection never closes, and the bottom valve seldom except where gross carelessness exists. The clogging usually occurs in the bottom connecting pipe where it passes through the hot space between the boiler front and the boiler. The only scale or sediment passing through the valve is what settles in the bottom pipe. On connecting globe valves it is good policy to place them sidewise instead of upright on horizontal pipes. This will eliminate the trap. JAMES E. NOBLE.

Kingston, Ont., Canada.

Regarding the comments on water-column blowoff valves by R. A. Cultra on page 27 of the July 1 issue, I can agree with him in some things, but think that he has placed too much stress on some of the points that he has brought out in his communication. It is true that mud, etc., will collect in the pocket formed below the seat of a globe valve, and there is danger of the valve plugging up unless it is blown out at intervals, this of course depending on the character of the boiler water. However, blowing down a water column is an excellent practice to cultivate, regardless of whether the boiler is using muddy and scale-forming water or not.

Mr. Cultra's argument concerning the placing of globe valves is one that has been up for years, and engineers have their opinion regarding the proper way of placing them in a pipe line. Regarding the pressure on the valve bonnet, it seems to me that if a valve is so frail that it will not withstand the pressure continuously, such as would be exerted against the bonnet with a pressure coming above the disk, it would be a good idea to get a valve of more sturdy construction.

If Mr. Cultra's article is to be taken seriously, then globe valves should not be applied to any line under pressure, whether the pressure comes on top or below the disk, because according to his statement the only time the valve would be safe would be when it was closed and the pressure against the valve bonnet would be exerted only against such area of the valve disk as was exposed to the pressure in the pipe. However, when a globe valve is open, as most of them are at some time or other, the bonnet is under the pressure of the pipe, and if it can withstand this pressure at one time it should be capable of withstanding it at another. As a matter of fact, many globe valves in steam lines are open most of the time; therefore the pressure is continually exerted against the valve bonnet.

As to packing the valve stem, I have yet failed to find a globe valve that I could not pack while under steam pressure, regardless of whether the steam was on top or below the valve disk. Of course, if the steam is leaking out past the valve stem, it is not as easy a job as it would be if there were no steam.

It is not apparent that the instance Mr. Cultra brings out regarding a globe valve so connected that the pressure came on top of the disk and an attendant using a wrench on the wheel to screw it up so tight that the bonnet was forced off is a good argument. The fault was not with the valve; it was a case of bull-headed ignorance, and the bonnet could have been forced off just as well whether the pressure was exerted under the valve disk or on top of it. It is a wonder to me that he did not force the valve seat away from the valve body as well as the bonnet out of the valve.

According to my experience, I think Mr. Pascoe gave a very good reason for placing his valve so that the pressure came on top of the disk, and it is my belief that such an arrangement with the blowoff valve attached to a water-column pipe or water-glass connection is not at all dangerous. E. A. JACKSON.

Baltimore, Md.

Remedy for Present Valve Setting

The accompanying indicator diagrams were taken from an 18 x 30-in. Corliss engine, double-eccentric, long-range cutoff, making 130 r.p.m. The diagrams shown in Fig. 1 were taken from the engine as I found it; diagrams Fig. 2 were taken after I had adjusted the valves the best I could. The valve chambers were bored out and new valves put in about eighteen months ago. The engine has been very wasteful of steam, and I was called in to see what I could do. I have made a saving in coal of about one ton per day of ten hours, but the engine pounds badly on the head end.

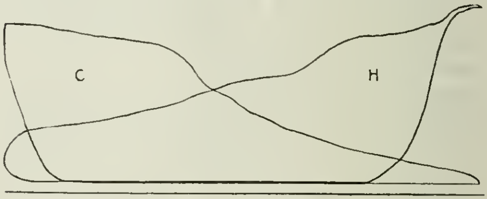


FIG. 1. DIAGRAM FROM ENGINE AS FOUND

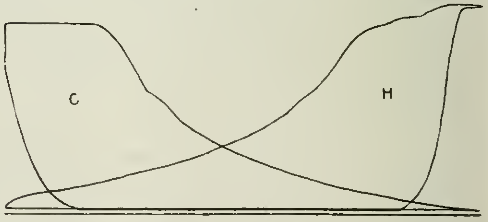


FIG. 2. DIAGRAM FROM ENGINE AS CHANGED

With a double-eccentric engine I understand that the steam valves should be open $\frac{9}{32}$ in. with the wristplate in the center. I found the head-end valve open $\frac{3}{8}$ in., and it is now open $\frac{5}{16}$ in. I cannot do any better, as the threads run out of the link head. The head-end steam valve is the only one I changed. There is no lead on this valve, and yet it is open with the engine on the center more than it should be. I would appreciate the advice of experts in double-eccentric engines. What should be done to get proper valve setting? S. L. GILLIAM.

Madison Heights, Va

Inquiries of General Interest

Disadvantage of Excessive Clearance—In a reciprocating engine operating with cutoff, if the exhaust is compressed to the initial pressure what effect has excessive clearance on the economy? S. J. R.

Excessive clearance is disadvantageous, as the high compression must be compensated by later cutoff, and consequently there must be a higher terminal pressure and less work of expansion out of the steam used by the engine.

Testing Safety Valves With Water Pressure—Cannot safety valves be tested satisfactorily with water pressure? E. M.

Steam or air safety valves should be tested with steam or air pressure, and water-pressure relief valves should be tested with water pressure; otherwise, in discharging, the valve is subjected to a different counterpressure than when relieving pressure under the conditions for which it is intended.

Theory of Injector—What is the theory of the action of an injector? R. B.

The steam passing from the high pressure in the boiler to the low pressure in the injector chamber expands suddenly so that a portion of its heat energy is converted into energy of motion. When condensed by contact with the water, it gives up some of its heat to the water, but retains enough of its kinetic energy to carry the water along with it against the pressure of the boiler.

Disposition of Heat in Gasoline Engines—In internal-combustion engines that use gasoline, what proportions of heat of the combustion are utilized in the generation of power, absorbed by cooling, and expelled in the exhaust? R. G. B.

The proportions vary with the type, design and load of the engine. Ordinarily, there is about 25 per cent. of the heat utilized in development of power, about 30 per cent. absorbed by jacket cooling water, about 40 per cent. discharged in the exhaust direct to the atmosphere, and about 5 per cent. of the heat lost by radiation.

Use of Brass for Pump Pistons—For handling hot water, why are pump-plunger pistons made of brass, and what is the advantage of brass piston parts for cold water pumps? P. K. D.

Hot water has a rapid corrosive action on cast iron and steel, and soft packing can be held tight for a longer time when the parts are made of brass. For pump pistons packed with soft packing, brass followers have the advantage over followers made of cast iron, as the latter sometimes break from swelling of the packing or from being set up too tight. When the follower rings are made of brass, they are only forced out of shape and usually can be restored to proper form by pressure or hammering.

Why Steam Valves of Duplex Pumps Have No Lead—Why is not lead given to the steam valve of a direct-acting duplex pump? C. W. M.

The pump must be capable of starting at any point of the stroke, and therefore the valve gear must provide for the steam to follow full stroke. With lead, steam would be admitted simultaneously on opposite sides of the piston, which could not then be started in either direction. The only purpose of lead in operation of the pump would be to stop the motion of the piston at the end of the stroke, and this is provided for by having each piston cover the exhaust passage near the end of the cylinder before completion of the stroke and thereby obtain a cushioning effect by compression of the exhaust thus entrapped in the space between the piston and the cylinder head.

Laminations in Boiler Plates—What is lamination of a boiler plate, why is lamination a source of danger, and how is the condition detected? W. F.

A lamination consists in separation of the material of the plate into layers that are not welded together, therefore lacking the strength and solidity of a perfect plate. With modern material the defect is rare, but in older practice, when wrought iron was the material employed for boiler plates, such defects were quite frequently met with, due to the presence of slag in the iron, which in the operation of rolling the plates would become thinned out into sheets separating layers of the iron and preventing them from becoming welded into a homogeneous plate. With continual changes of temperature and consequent expansions and contractions, it frequently happens that the laminations become separated and the thinner portion of the structure becomes raised, forming a blister. The chief danger from such a blister on the heating surface arises from the nonconductivity of heat and the danger of the plate becoming burnt or ruptured from becoming overheated. In examining a plate for laminations that are not apparent from the appearance of blisters, the hammer test is usually considered the most reliable. The plate is tapped over its surface, and an experienced ear can usually detect the location and approximate extent of lamination.

Different Water Levels in Connected Heating Boilers—The low-pressure gravity-return steam-heating system of a large public building is supplied by two cast-iron sectional boilers that are about 16 ft. apart and are connected to the main steam and return lines. The boilers are in duplicate and set at the same level. In the operation of the heating system trouble is experienced in maintaining the same water level in each boiler. What is the cause, and how can the trouble be remedied? R. G. M.

The trouble undoubtedly arises from difference in loss of pressure in the return water for overcoming friction of flow, and would be caused to some extent by the least variation in size, length and roughness of the return connections. Similar difference in frictional resistance to flow is shown by the different rates at which the water levels would drop from a common level if the boilers were emptied under atmospheric pressure, with discharge taking place through apparently identical outlet connections. Variation in the residual pressure results in maintenance of a different hydraulic head of water in the boilers, above the common connection with the main return. The loss of pressure from friction increases as the square of the velocity, and the difference of water level of the boilers increases faster than the increase in rate of water presented by the main return. With ordinary sizes of steam connections, the steam pressure in the boilers would be substantially the same, even for considerable difference in rates of evaporation, and although commonly attributed to difference of steam pressure, trouble from that cause is rare. The remedy is to make the cross-sectional areas of water connections to both boilers so large that the return water will have a very low velocity through the connections, with little loss and smaller difference of residual pressure. This can be accomplished by supplying larger connections or additional return connections. Difference in water levels of connected boilers cannot be entirely eliminated. The safest method of operation would be to use the boilers disconnected from each other and for independent sections of the heating apparatus.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Pulverized Coal as a Fuel for Boilers*

BY EDWARD R. WELLES AND W. H. JACOBI

IN SPEAKING of the advantages and disadvantages of pulverized coal as a fuel, they may be stated as follows:

a If ground sufficiently fine the the entire combustible content of the coal can be burned, thereby effecting fuel economies hitherto not attainable even with the better grades of coals burned under favorable conditions.

b It permits the use of all grades of coal, including peat and lignite, with an approximately equal degree of thermal efficiency for the same service, and increases very materially the energy that can be derived from the world's supply of coal.

c It possesses very largely the facility of control and combustibility of oil and gas fuels, thereby placing coal on a parity with these fuels.

The limitations of pulverized coal are:

a The very high temperatures attending its efficient combustion (see table) and the unsteady mode of its deflagration, necessitating special furnace construction to secure reliable service and to realize the possible economies it affords, preclude its ready application to existing equipment.

b The operating cost and attention required to maintain the necessary apparatus for its use may more than offset the fuel economies that can be effected in small independent services.

c The presence of ash, which may not always be collected and held under control.

d The human element, which will not submit to the peculiarities of its nature.

APPROXIMATE COMBUSTION TEMPERATURES OF CARBON AND BITUMINOUS COAL AND THE RESULTING PERCENTAGES OF CO_2

Percentage of excess air	0	25	50	75	100	125
Combustion temperature, deg. F.:						
Carbon	4,000	3,450	3,000	2,625	2,350	..
Average bituminous coal	4,860	4,000	3,325	2,860	2,500	2,220
CO_2 per cent	20.8	16.5	13.8	11.8	10.2	....

For flexibility and nicety of operation gaseous fuels rank first, being followed respectively by liquid fuels (oils), powdered coal and solid (lump) fuels. On the basis of cost they assume exactly the reverse order. Economy depends on the nature of the service and local conditions.

PREPARATION OF PULVERIZED COAL

The valuable feature of pulverized coal is that by reason of its divided state it can be brought *en masse* into intimate contact with the air necessary for its combustion, and in consequence, when injected into a suitably heated hearth it burns completely, deflagrating almost as readily as atomized oil.

Obviously, the first requisite is to render the fuel into as fine particles as is possible, so that when mixed with air the mixture shall assume the form of a homogeneous gas. This analogy is comparative only, for no matter how finely broken and thoroughly mixed with air the coal particles are, they retain their solid structure and are therefore subject to a very arduous process of combustion, which is responsible for the attendant high temperatures that result.

The standard established in cement-mill practice, generally adopted for all purposes, is that 85 per cent. of the powder shall pass through a 200-mesh screen, and 95 per cent. through a 100-mesh screen. Coal so ground weighs from 35 to 45 lb. per cu.ft. and 1 lb. of it can be carried in suspension through smooth piping in about 5 lb. of air moving at low velocities. Experience shows that under favorable conditions 100 per cent. 60-mesh powder can be burned satisfactorily. This coarse fuel necessarily requires a longer time for its complete combustion and it can be carried in suspension only at high velocities. Its use, therefore, would be permissible only in furnaces which provide a long path for the resulting flame. In short chambers operating at low velocities these large particles fall to the bottom of the chamber before being consumed and coke, the result being a loss of fuel.

Granulated coal ranging in size from one-fourth inch to powder has been used as fuel for boilers aboard ship, it being blown into specially constructed hearths. This method has given good results in forcing the generation of steam, but it is not strictly in the class of burning pulverized coal in suspension and does not possess the same range of possibilities.

Coarsely pulverized coal has the redeeming quality of damping the temperature of the furnace and may be resorted to for the purpose of cooling overheated hearths without chilling; nevertheless, pulverized coal larger than the 80-mesh grade should be avoided in ordinary operation for best results. A uniform mixture averaging 100 per cent. 150-mesh or finer should be employed, especially in the case of low-grade coals.

Pulverizing mills ordinarily produce powder of the cement-mill standard, and on the basis of fairly dry coal the average cost of pulverizing runs from 15 to 30c. per ton ground at the rate of $2\frac{1}{2}$ to $1\frac{1}{4}$ tons per hour, respectively.

FURNACE AND COMBUSTION LOSSES DECREASED

With pulverized coal, furnace and combustion losses can be greatly decreased as compared to those incurred in burning lump coal over grates, by reason of its manner of burning, and it is to that condition alone that very acceptable fuel economies can be effected by its use. Instances are recorded showing that 10,500-B.t.u. coal fired as powder in a given boiler setting has evaporated a larger amount of water than 12,090-B.t.u. coal fire by hand.[1] Invariably, records of tests made in steam plants of various capacities using pulverized coal as fuel indicate boiler thermal efficiencies of 75 to 80 per cent. and over, which parallel the best efficiencies obtainable with modern stokers in large installations. The consensus of opinion is that with the better methods of firing pulverized coal the high efficiencies observed, both in the hearth and in the boiler, remain fairly constant throughout a wide range of quantities of fuel burned, whereas with stokers, which permit only a rigid design of combustion hearth, beginning with the higher efficiencies in large boiler installations the efficiencies drop as the installations become smaller. This is self-evident in part, since in stoker practice only the better coals can be used to advantage and a certain amount of fuel loss cannot be prevented, whereas by pulverizing, all grades of commercial coals are admitted to the same service with equal merits and fuel losses may be avoided. And since deflagration, and therefore the combustion space necessary, becomes a measure of the actual amount of combustible present in the coal, the hearth losses remain practically constant for all conditions encountered in actual service.

The conclusion to be derived is that, other things being equal, the competition between the use of pulverized-coal firing and stokers for large boiler plants will be a matter of flexibility of service, convenience in operating and maintenance cost; but in small plants fuel economy will be the deciding feature along with the other advantages, and pulverized coal will obtain the preference, not only on the basis of combined first and operating costs, but especially so after the greater convenience and flexibility demonstrated.

PROPER VELOCITY FOR FUEL MIXTURE

The proper velocity for the fuel mixture as determined by its inflammability can be found only by trial, and the condition to be fulfilled is that the base of the flame shall approach the outlet as closely as possible. A lower velocity may result in backfiring within the feed tubes, which are of appreciable dimensions, and cause a more or less destructive explosion. A higher velocity carries the mixture too far into the hearth before combustion begins, and has the effect of coking and consolidating the particles, which drop to the bottom of the hearth in the form of relatively large globules, thereby causing faulty combustion and loss of fuel. Coking of the combustible charge is very perceptible in connection with discharge outlets of large diameter such as are used in cement kilns. The action in this case has been attributed to more rapid combustion on the surface of the combustible jet, which has the effect of baking the core within. This difficulty has been overcome by using outlets in the form of a slot of the required cross-section, thereby exposing more surface to the hot gases in the hearth.

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*Abstract of a paper presented at the Spring Meeting of the American Society of Mechanical Engineers.

[1] G. F. Gashe, *Railroad Gazette*, vol. 34.

VOLUME OF FLAME OR ZONE OF OXIDATION

The volume of the flame—that is, the zone of oxidation—in general, cannot be predetermined on account of the many uncontrollable variables, and especially because the virtual temperature of combustion cannot be ascertained by present means and the real time element of complete oxidation is not definitely known. Observation and analysis show that, under similar conditions, more inflammable fuels burn with a shorter flame than the less inflammable. In connection with pulverized coal the problem becomes more complex on account of the variable amount of excess air required for its combustion. The values for this excess hitherto suggested vary widely and are so conflicting as to preclude their use. Nevertheless, based on the average temperatures of combustion and the amount and temperature of the gases required, it is possible to arrive at a very satisfactory conclusion regarding the dimensions for the combustion and gas space.

Briefly, though in the combustion of pulverized coal there is a wide margin for regulation by judiciously applying the conditions herein indicated, nevertheless, until more complete experimental data are available, it is necessary to consider every element entering—from the nature of the coal to the performance of the boiler—and to disregard all precedent existing in the burning of lump coal in order to secure satisfactory results with the powdered fuel.

Although in general furnaces are more or less special structures and their character is determined by the service they perform, their design and type of construction depend chiefly on the nature of the fuels used in their operation.

The combustion of a fuel results in gases charged with the available useful heat developed during their formation, and ash, in the case of fuels containing solid impurities. The quantity of gases and their temperature depend on the quality of the fuel and the amount of air used for combustion and dilution purposes, which can be varied to suit practical requirements.

In steam-boiler settings the duty of both boiler and furnace is a calorific one—that is, one of straight heating—and is measured by the amount of water evaporated in the boiler by the combustion gases from one pound of fuel.

The amount of water that can be evaporated in any type of boiler by a given quantity of fuel depends on the quality of the steam desired and the ability of the boiler to absorb the heat charge of the gases supplied by the furnace necessary for the generation of the steam required. So that, briefly stated, the boiler is subordinate to the steam requirements and the furnace subordinate to the performance of the boiler; and just as the design of boiler is varied to satisfy the steam requirements, so must the furnace proportions and mode of burning coal vary to supply the necessary gases for the efficient operation of the boiler, and in so doing secure the greatest fuel economy.

The nature of fuels plays the all-important part in the efficiency and performance of furnaces, regardless of their calorific value. By pulverizing and proper treatment all grades of coals may be dealt with on the basis of their burnable content, thereby rendering their use equally applicable to all heating services.

DESIGN OF PULVERIZED-FUEL FURNACES FOR A 500-HP. BOILER

To demonstrate the possibilities of pulverized fuel along the lines indicated, a furnace for burning efficiently all grades of coal from the average best bituminous and anthracite qualities to lignite, and of such size as would be applied to a water-tube boiler of about 500-hp. capacity, has been designed, particles being given in the following paragraphs.

In working out this design for a boiler with a steam pressure of 175 lb., and working at 100 per cent. and 200 per cent. rating, consideration has been given to the best features of furnaces successfully burning pulverized coal and fuel oil. The temperatures of the gases delivered to the boiler have been assumed to be 1800 deg. F. and 2750 deg. F., respectively, for the two ratings, the boiler efficiency being taken at approximately 80 per cent. in both cases.

The purpose of this design is to study the possibilities of meeting as severe demands as are made at the boiler ratings selected, using all grades of powdered fuel.

The distinctive features of this furnace are the delivery of the fuel mixture and of the dilution air to insure perfect combustion, to permit regulation of the fire, and to guard against the slagging and destructive difficulties heretofore encountered. The air is supplied by suitable blowers and is heated before use by the waste flue gases for fuel mixing and by the body of the furnace for dilution purposes.

Regulation is accomplished by control of the fuel and of the air, the fuel-mixture spout outlets being proportioned to deliver, at maximum duty, a mixture containing 75 per cent. of the air required for perfect combustion.

PURPOSE OF THE AIR JETS

The purpose of the air jets under the flame is to blow toward the ashpit the ash particles that may fall from the flame as well as the partly consumed particles of fuel. The latter are brought into the deflagration zone with a fresh supply of air and given a new chance to burn completely.

Rows of air jets on top of the flame are for the purpose of directing the flame over a longer path and providing thereby longer time for the complete oxidation of the fuel particles, protecting the furnace from the hottest portion of the flame and for aiding in the precipitation of ash toward the ashpit. Aside from supplying additional combustion and dilution air, the joint effect of the two rows of air jets is to carry the flame in suspension away from the furnace walls and the ash deposit, and fulfill thereby one of the principal requirements for the burning of pulverized coal.

THE ASH MUST BE BLOWN OFF OCCASIONALLY

The idea of precipitating the ash by rapidly expanding the flame into a large space is applied, but it is not expected that all the ash can be thus collected. Some of the ash dust will be carried by the gases and deposited on the boiler tubes and surfaces beyond the hearth and must be blown off occasionally by soot blowers to a collecting hopper in the rear chamber of the boiler setting, from which it is discharged in a manner similar to that employed in removing the ash from the furnace.

The furnace design, though possessing good features, is not necessarily typical. In an actual case the conditions of the service would influence largely the most suitable arrangement.

Furnaces for burning pulverized fuel demand careful consideration, not so much on account of the novelty of the fuel, but because, like other fuels, it possesses its peculiarities, which do not obey a general rule and which must be carefully considered to secure the maximum of usefulness for each kind and size of service.

No comprehensive surveys for hydro-electric development have been made in the Philippines, and at present there are few water-power plants, though several are under consideration, notably one for the Manila Electric Railway and Light Co. Much interest is being shown in the subject owing to the rise in the price of coal from $4 per ton in 1914 to $30 in 1919. The rainfall in many places is ample, but the main difficulty is with adequate storage facilities. There is, however, a place in Mindanao where 250,000 hp. could be developed; the location is remote from populous centers, but near good iron ore.—*Commerce Reports.*

California 220,000-Volt 1100-Mile 1,500,000-Kw. Transmission Bus*

By R. W. Sorensen, H. H. Cox and G. E. Armstrong

California has available ample hydro-electric power to supply the industrial and agricultural demand for many years. Small developments aggregating 325,000 kw. have been completed, and many others of this type are available. There are also four large projects as given in Table I, which can readily be developed to a capacity of 1,500,000 kw. in the near future. The data for the following tables of resources and loads, of the northern part of the state, are taken from various reports that have been published, and no attempt has been made to verify them.

TABLE I. LARGE POWER RESOURCES

	Now Developed and Under Construction, Kilowatts	Proposed Developments, 1926, Kilowatts	Reasonable Future Development (Not Ultimate Capacity), Kilowatts
Pitt River	None	200,000	500,000
Feather River	100,000	200,000	300,000
Big Creek	100,000	300,000	500,000
Colorado River	None	None	200,000
Total	200,000	700,000	1,500,000

Total 1926 hydro-electric power development including small projects is 1,025,000 kw.

The best available information indicates a demand in 1926 approximately as shown in Table II.

TABLE II. DEMANDS FOR POWER ALONG PROPOSED DEVELOPMENT

		Kilowatts
1.	Sacramento Valley, northern portion	70,000
2.	Truckee River electrification	40,000
3.	Sacramento Valley, southern portion	125,000
4.	San Francisco Bay District	250,000
5.	Fresno District	90,000
6.	Bakersfield District, including Tehachapi electrification	125,000
7.	Los Angeles District	300,000
8.	Barstow and Needles District, including railroad electrification	40,000
	Making a total of	1,040,000

In order to carry this load, approximately 500,000 kw. additional in hydro-electric capacity will be required. A demand such as shown in Table II can be supplied most economimally by power developed in large units. Large power units require transmission lines of the highest possible economic voltage.

It has been shown that, for long transmission, 220,000 volts is economical under conditions that require a much more expensive construction than has proved adequate for the 150,000-volt lines of the Southern California Edison Co.[1] On this basis a plan as shown on the map is proposed. In this plan the interconnection of all the California power companies has been assumed, as an economic necessity for its best utilization. Interconnections of limited capacity are not entirely satisfactory because they fail just at the time they are needed most to transfer from one system to another large blocks of power.

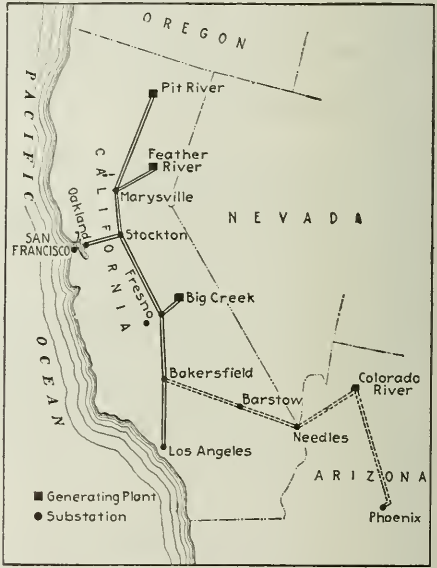
The plan of the proposed scheme involves the construction of a two-circuit transmission system extending from Pitt River to Los Angeles, a distance of 570 miles. Branch lines of like voltage connect the three other power projects and the San Francisco load center to this main line on which the other load centers are located. The main line thus becomes a high-tension bus extending nearly the entire length of the state; hence its name, California Transmission Bus. This arrangement makes possible unlimited interconnection and exchange between all the power companies of the state.

Substations have been located at Marysville, Stockton, San Francisco, Fresno, Bakersfield and Los Angeles. These points are natural load centers and suitable points for connecting with the present power systems. On the Colorado-River branch, the construction of which is dependent upon the electrification of the transcontinental railroads, substations would probably be located at Barstow and Needles. The substations divide the lines into sections of suitable length for practical operation, the longest section being 150 miles, as shown in Table III.

TABLE III. DISTANCES BETWEEN SUBSTATIONS AND FROM POWER STATIONS TO LOAD CENTERS

	Miles
Pitt River to Marysville	150
Feather River to Marysville	60
Marysville to Stockton	90
Stockton to San Francisco	60
Stockton to Fresno	130
Big Creek to Fresno	40
Fresno to Bakersfield	100
Bakersfield to Los Angeles	100
Bakersfield to Barstow	110
Barstow to Needles	150
Needles to Colorado River	100
Colorado River to Phoenix	100
Pitt River to San Francisco	300
Big Creek to Los Angeles	240
Big Creek to San Francisco	230

The standard frequency, 60 cycles, has been assumed on the basis that the southern California power systems, now operating at 50 cycles, will ultimately find it advantageous to conform to the A. I. E. E. standard. In the natural growth of the load shown in Table II, 70 per cent. of the 1926 load will be supplied by the 60-cycle systems. Interconnection of such large load centers or power sources through frequency changers, limits the exchange of power, is uneconomical, and increases tremendously the required operating vigilance.



CALIFORNIA 1100-MILE 220-KILOVOLT TRANSMISSION BUS

The practicability of the high-voltage line has been well demonstrated by over five years of remarkably successful operation of the 150,000-volt lines of the Southern California Edison Co., which, during this period, have delivered from the Big Creek power houses over the 240-mile lines to the Los Angeles distribution system, 1,200,000,000 kw.-hr. at an average efficiency of 87.5 per cent. with a 45 per cent. load factor. During this period there have been no interruptions for which the high voltage is responsible, and on the contrary the system has been free from disturbance and interruption to a greater degree than the lower-voltage lines in the same locality.

The present Big Creek lines can be operated at 220,000 volts 60 cycles without material change, and this is proposed as a link of the transmission bus, and its operation under these conditions will be analyzed and applied to conditions of the proposed system.

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*Abstract from a paper presented at the American Institute of Electrical Engineers Pacific Coast Convention, held in Los Angeles, Calif., September, 1919.

[1] Silver, Problems of 220-Kv. Power Transmission, A. I. E. E. Proceedings, June, 1919.

International Trade Conference at Atlantic City

An international Trade Conference will be held at Atlantic City Sept. 30 to Oct. 3, by invitation of the Chamber of Commerce of the United States. An exceptional program has been arranged. Under the heading of Major Topics is scheduled economic readjustment of commercial and industrial conditions in England, France, Italy and Belgium. Finance will be another general subject. It includes foreign exchange and all the forms in which questions of credits may arise. Under this subject there will be discussion of the various plans for extending credits which have been proposed in the United States.

Fair play in international commercial competition will likewise be promoted. Questions of food and of the cost of living will have a prominent place on the program, according to the plans that have been made in advance.

There will be an American committee for every subject, including producers, shippers and economists who will meet from day to day with the foreign delegates, who have been making careful preparations for the conference and will come fully equipped to give the American public the information needed on all the subjects outlined.

Alone, experience will not carry a man to his ultimate goal in power-plant work—it requires ingenuity, loyalty, study, sympathy and a vision of greater service to round out his real value. These characteristics should not be overlooked in measuring a man's ability. All too frequently, because of their inherent invisibility and peculiarly personal nature, these factors are not listed on the credit side of the ledger, and Old Man Experience cultivates an exaggerated idea of his importance.—*Refrigerating World.*

A noted English jurist says: "The longer I live the more certain I am that the great difference between me, between people and the powerful, is energy—invincible determination—a purpose once fixed and then death or victory. That quality will do anything that can be done in the world; no talent, no circumstances, no opportunities, will make a man a two-legged creature without it."—*The Monad.*

A steady increase in the American exports to Australia is noticeable since 1913, in which year machinery and metal manufactures amounting to $14,654,183 were sent to the island continent. In 1914-15, $15,283,903; in 1915-16, $16,046,055; in 1916-17, $18,435,108; and in 1917-18, $19,066,503. —*Commerce Reports.*

New Publications

EXERCISES IN LETTERING. By George G. Greene. Published by the Bruce Publishing Co., Milwaukee, Wis., 1919. Paper, 2½ x 5¼; 32 pages.

These little books are vest pocket editions of the slant gothic and the vertical gothic styles of lettering and are especially adapted to the use of the mechanical draftsman. The construction of the letters is explained and illustrated. A separate complete alphabet with the figures is inclosed with each volume and may be pinned to the drawing board for reference.

COLLOIDAL FUELS

"Colloidal Fuels" is the title of a 28-page bulletin recently published by Lindon W. Bates, 141 Broadway, New York City. It embodies matter and studies not heretofore published, particularly the demonstration as to the relative efficiencies and advantages of liquid versus solid fuel. The relation of colloidal fuels to coal, to the production of power and heat and to fire prevention and insurance is well presented.

Personals

Frank B. Fairbanks is now advertising manager of the Duff Manufacturing Co., Pittsburgh, Penn.

F. C. Pratt, who has been assistant to the vice president of the General Electric Co., was recently elected vice president.

Col. E. H. Abadie has been appointed comptroller of the division of operations of the United States Shipping Board in place of John J. Nevin, resigned.

F. A. Moreland, resigned his position as treasurer of the Vulcan Fuel Economy Co., Chicago, Sept. 1, having been connected with the company since early in 1910.

John Kelly, who for a number of years was New York district manager of the Edison Storage Battery Co., has been appointed general sales manager of the company, with headquarters at Orange, N. J.

C. H. Johnson, who has been chief engineer in charge of power stations of the Columbus (Ohio) Railway, Power and Light Co. for the last two years, has resigned to take a position with the Combustion Engineering Co., New York City.

F. H. Van Gorder has been appointed manager of the Western Electric Co.'s Newark (N. J.) store. He has been connected with the company since 1907, successively as salesman with the Chicago house, the Detroit store, and as power apparatus specialist at the New York office.

A. M. Dudley, who has been engineer-in-charge of alternating-current motor design of the Westinghouse Electric and Manufacturing Co. for a number of years, has been promoted to the position of engineer-in-charge of automotive equipment design of the company.

R. H. Ballard, president of the National Electric Light Association, left Los Angeles Sept. 12 on a second Eastern trip in the interests of the organization. He will attend a meeting of the Public Policy Committee which has been called by Chairman John A. Britton, to be held at Association headquarters in New York on Oct. 1. Taking advantage of President Ballard's presence in the East, a general meeting of the membership committee has been called by Chairman Walter Neumuller, of New York, and of the Company Sections Committee by Chairman Frank A. Birch, of Philadelphia. Both of these meetings will be held in New York. Mr. Ballard will stop in St. Louis on Sept. 15 for a discussion of association affairs in that section of the country with company executives residing in that region. He will address the convention of the Southeastern Section, which will be held at Asheville, N. C., Sept. 17-19, on the morning of Sept. 18. He will return to New York on Sept. 24, after attending the New England Section Convention, and will be at headquarters for the following two weeks, returning to the Pacific Coast in October, after scheduled stops at Detroit, Chicago, Minneapolis, Butte, Seattle, Portland and San Francisco.

Engineering Affairs

The National Association of Stationary Engineers, at the recent annual convention, voted to authorize the national president to confer with the Canadian Association of Stationary Engineers looking toward closer relations between that body and the N. A. S. E., the committee to report to the next national convention. The newly elected officers of the ladies' national auxiliary for the next year are: President, Anna C. Artkamper, Chicago, Ill.; vice-president, Mary E. Lamb, Pittsburgh, Penn.; secretary, Lenore W. Farmer, Columbus, Ohio; treasurer, Mary T. Mahon, Chicago, Ill.; chaplain, Anna Morris, Wilmington Del.; doorkeeper, Catharine Bastian, Chicago, Ill.; conductor, Sophie Legner, Cincinnati, Ohio. Gertrude P. Hunt, chairman pension fund soliciting committee, and Sadie Armer, chairman pension fund booster committee.

Miscellaneous News

Tennessee River Power Plants—Extensive plans are being made for the erection of a series of power plants on the Tennessee River. The plans propose the erection of six or more dams between Knoxville and Chattanooga. The entire enterprise, it is predicted, will cost between $16,000,000 and $20,000,000.

The New England Water Works will hold its thirty-eighth annual convention in Albany, N. Y., Sept. 30-Oct. 3, with headquarters at the Hotel Ten Eyck. Among the various papers to be presented the following are of interest to *Power* readers: "Pumping Engines for Small Water Works Plants," by Creed W. Fulton; "Tests of the Uniflow Pumping Engine," by D. A. Decrow.

The New Million Dollar Laboratories of the Bureau of Mines, Department of the Interior, Pittsburgh, Penn., will be dedicated Sept. 29-Oct. 1. The ceremonies promise to bring to Pittsburgh for the three days the most prominent mechanical engineers and mining and metallurgical men of the nation. The Bureau of Mines, in co-operation with the Pittsburgh Chamber of Commerce, has already completed an elaborate program of events, which includes the presence of high and state government officials besides the leading men of scientific and mining thought in the country. Dr. Van H. Manning, Director of the Bureau, will preside at the dedicatory ceremonies.

Business Items

E. B. Badger & Sons Co., Boston, Mass., has opened an office in Chicago, with Harry E Wheeler in charge.

The Ashton Valve Co., Boston, Mass., announces that Willson & Morison, 408 Rialto Building, have been appointed as the company's exclusive agents for that territory.

The Western Electric Co. has recently opened a new branch sales office and warehouse, at 334 East Bay St., Jacksonville, Fla., in charge of A. H. Ashford.

The Williamsport Wire Rope Co., Williamsport, Penn., has opened a branch office and warehouse in Chicago, the office at 122 South Michigan Ave., and the warehouse at 755 West Quincy St., under the direction of C. M. Ballard, formerly connected with the company's Cleveland branch office.

Trade Catalogs

The Culm Burn Grate Co., Philadelphia, Penn., has issued a bulletin describing the "Culm Burn Grate," which shows how coal dirt may be made 98.81 per cent. efficient.

The De Laval Separator Co., New York City, has recently issued bulletins Nos. 100, 101, 102 and 103, all having reference to the De Laval method of oil purification. Bulletin No. 100 devotes 23 pages to lubricating oils, cutting oils, hardening oils and fuel oils. Bulletin 101 devotes 16 pages to a manual for reclaiming, cutting and hardening oils. Bulletin 102 devotes 20 pages to the De Laval method of reclaiming crank-case oils. Bulletin No. 103 has 12 pages describing the De Laval method of purifying and reclaiming oils. All four bulletins are well illustrated and contain much useful information.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7 95
Stove	7.95@8 15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F. o. b. mines, net tons	$2 40@2.85	$2.90@3.35
F. o. b. Philadelphia, gross tons	4 55@5.05	5.10@5.60
F. o. b. New York, gross tons	4 90@5.40	5 45@6.05
Alongside Boston (water coal), gross tons	6.65@7.15	7 20@7.75

Georges Creek is quoted at $3.70 per net ton, f. o. b. mines.

Pocahontas and New River are quoted at $6 00 @6 50 per gross ton f. o. b. Norfolk and Newport News, Va., in response to export demand. There continue practically no sales for coastwise shipment. On cars Providence these grades are quoted at $9.00 @9 25.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5.95	$7 80	Pea	$5.30	$7.05
Egg	6 35	8.20	Buckwheat	3.40	5.15
Stove	6.60	8.45	Rice	2 75	4.50
Chestnut	6 70	8.55	Barley	2.25	4.00

Bituminous

Current quotations on spot coal, net tons, at the mines average about as follows:

	Spot
South Fork (best)	$3.25@3.50
Cambria (best)	3.00@3.25
Cambria (ordinary)	2.70@2.90
Clearfield (best)	3.00@3.25
Clearfield (ordinary)	2.70@2 90
Reynoldsville	2.85@2.90
Quemahoning	3 25@3.50
Somerset (medium)	3 00@3.25
Somerset (poor)	2.65@2.75
Western Maryland	2.65@2.75
Fairmont	2.50@2.65
Fairmont ¾ in	3.10@3.25
Latrobe	2.75@2.90
Greensburg	2.75@3.00
Westmoreland ¾ in	3.50@3.75
Westmoreland run-of-mine	3.20@3.35

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide	Anthracite	Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	6.35	8 20	Rice	2.75	3.65
Stove	6.60	8 45	Boiler	2.50	3.50
Nut	6.70	8.55	Barley	2.25	3.15
Pea	5.30	6 90			

PITTSBURGH—Counting out occasional low and high priced sales involving but small tonnage, the great bulk of the transactions is quotable as follows, Pittsburgh District:

	Per Net Ton
Steam:	
Slack	$2 10@2 30
Mine-run	2.50@2.60
Gas:	
Slack	2.20@2 40
Mine-run	2.50@2 70
Prepared sizes	2.60@2.90

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2 30@2 60	$2.30@2 60	$2 40
Black Creek and Cababa	3 45@3.85	3.45@3.85	3.05
Jagger - Pratt Corona	2.85	3 00	2 45
Blacksmith	....	5.25	.....

Domestic quotations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cababa	5 00@$5 50
Corona	3 50
Jagger	3.50
Montvallo	5.50@$6.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

	Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$3 25	$2.75@3 00	$2 75
Mine run	2.40*@2.60	2 25@2 40	2 00@2.20
Screenings	2.10*@2 30	1 75@2.00	2.00

* Indicates prices on independent coal

Williamson-Franklin rate to St Louis is $1 07½; other rates $0.92½.

New Construction

PROPOSED WORK

Mass., Amherst—James H. Ritchie, Arch., 8 Beacon St., Boston, will receive bids for the construction of a 3 story, 60 x 155 ft. dormitory and dining room, for the Massachusetts Agricultural College, here. A hot water heating system will be installed in same. Total estimated cost, $150,000.

Mass., Belchertown—The Massachusetts Committee on Mental Diseases will receive bids September 29 for the construction of a 2 story, 64 x 89 ft. dormitory and a 3 story, 88 x 103 ft. power house, on State Grounds, for the Massachusetts Hospital, here. Two tub boilers and two engines will be installed in same. Kendall & Taylor Co., 93 Federal St., Boston, Arch.

Mass., Thorndike—Leary & Walker, Engr., New Bedford, will soon award the contract for the erection of a 6 story, 75 x 163 ft. factory here, for the Thorndike Co. A steam heating system and electric power will be installed in same. Total estimated cost, $175,000.

Conn., East Norwalk—Crofut & Knaff, Water St., South Norwalk, retained Fletcher-Thompson, Inc., Engr., 1089 Broad St., Bridgeport, to prepare plans for a 5 story, 60 x 300 ft. and 3 story 210 x 300 ft. factory and a 1 story, 60 x 150 ft. power plant, on Van Zandt Ave. Total estimated cost, $500,000.

Conn., New Haven—J. A. Wetmore, Supervising Architect, Treasury Department, Washington, D. C., received bids for installing motor driven triplex pumps in the Post Office here, from John R. Proctor, 74 Courtland St., New York City, $1465; John D. Kelly, 93 Meadow St., New Haven, $1861; E. S. Downs Co., 756 Broad St., Newark, N. J., $2414.

N. Y., Brooklyn—Kahan & Feldman, 25 Madison Ave., New York City, had plans prepared for the construction of a 5 story, 80 x 295 ft. factory, on Suydam St. between Wyckoff St. and Irving Ave. A steam heating system will be installed in same. Buchman & Kahn, 56 West 45th St., New York City, Engr. and Arch.

N. Y., Kings Park—The State Hospital Commission, Capitol, Albany, received bids for installing heating system in the proposed hospital for Acute Patients at Kings Park State Hospital, here, from A. B. Barr & Co., 6 River St., Yonkers, $21,800; Adams Britz & Co., Inc., 1769 Park Ave., New York City, $21,900; E. Rutzler Co., 404 East 49th St., New York City, $22,327. Noted Sept. 2.

N. Y., Lockport—Paul A. Davis, Arch., 1713 Samson St., Philadelphia, Pa., will soon receive bids for the construction of a 1 story 50 x 60 ft. bank building, for the National Exchange Bank, 45 Main St. A steam heating system will be installed in same.

N. Y., Marcy—The State Hospital Commission, Capitol, Albany, will receive bids until Oct. 7, for the construction of a 1 story, 65 x 280 ft. heating building and a 1 story, 80 x 120 ft. boiler room at the Utica State Hospital here. Equipment includes three 500 h.p. boilers, two fan blowers, one 125 kw., one 75 kw. generators, pumps, motors, etc. Total estimated cost, $500,000.

N. Y., New York—The Board of Education, 500 Park Ave., is having plans prepared for the construction of a 4 story, 92 x 194 ft. school on Bathgate Ave. and 182nd St. A steam heating system will be installed in same. Total estimated cost $420;000. C. B. J. Snyder, Municipal Bldg., Engr.

N. Y., New York—The Eagle Pencil Co., 703 East 13th St., will soon award the contract for the construction of a 6 story, 75 x 200 ft. factory on Avenue D, between 13th and 14th Sts. A steam heating system will be installed in same. Buchanan & Kahn, 56 West 45th St., Engr. and Arch.

N. Y., New York—M. Hausle, Arch., 3307 3rd. Ave., Bronx Boro., is preparing plans for the construction of a 2 story asphalt plant. A steam heating system will be installed in same. Total estimated cost, $100,000. Owner's name withheld.

N. Y., New York—M. Hausle, Engr., 3307 3rd. Ave., Bronx Boro., is in the market for heaters, conveyors, motors, boilers and elevators to be installed in a proposed plant. Owners name withheld.

N. Y., New York—J. A. Wetmore, Supervising Architect, Treasury Department, Washington, D. C., rejected bids for the construction of the temporary boiler plant in the U. S. Marine Hospital, here.

Pa., Philadelphia—The American Preserve Co., 946 Beach St., is having plans prepared for the construction of a 5 story, 80 x 250 ft. factory, and a 1 story, 50 x 70 ft. boiler house, on 3rd and Lehigh St. A steam heating and vacuum system will be installed in same. Peuchert & Wunder, 310 Chestnut St., Arch. and Engr.

Pa., Philadelphia—The Marcus Felt Realty Co., 1303 Market St., plans to construct a 20 story, 75 x 150 ft. store and office building on Market and 13th St. A steam heating system will be installed in same. Total estimated cost, $2,500,000. Graham, Anderson, Probst & White, Railway Exchange, Chicago, Arch.

Md., Baltimore—Israel Silberstein, 607 Equitable Bldg., plans to construct a 10 story, 140 x 181 ft. auto exchange building on St. Paul and Pleasant St. Sub bids will be taken on steam heating plant. Total estimated cost, $1,000,000. G. R. Callis, Jr., Melvin Ave., Catonsville, Arch.

N. C., Brevard—Transylvania County will receive bids until October 13 for the construction of a 3 story, jail and court house. Total estimated cost, $150,000. Heating and plumbing bids will be received separate from construction bids. T. E. Davis, Asheville, Arch.

S. C., Charleston—Spec. 4010—The Bureau of Yards and Docks, Navy Department, Washington, D. C., received bids for installing mechanical stokers in power plant here, from the Westinghouse Electric & Manufacturing Co., Hibbs Bldg., Washington, D. C., $10,391; Sanford Riley Stoker Co., 25 Foster St., Worcester, Mass., $14,520; American Engineering Co., Aramingo and Cumberland St., Philadelphia, Pa., $15,450. Noted Sep. 2.

Ohio, Cleveland—J. N. Ackerman, Engineers Bldg., plans to construct a 1 story, 100 x 500 ft. moving picture studio on West 25th St. A steam heating system will be installed in same. Total estimated cost, $500,000.

Ohio, Cleveland—The Altamont Realty Co., Williamson Bldg., plans to construct a 6 story, 99 x 125 ft. office building at 1730 East 12th St. A steam heating system will be installed in same. Total estimated cost, $350,000.

Ohio, Ceveland—J. Babin, 13661 Euclid Ave., plans to construct a 5 story, 85 x 286 ft. commercial building on Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—The Cleveland Public Library Association, 1375 Euclid Ave., is receiving bids for the construction of an 8 story, 200 x 400 ft. public library on East 3rd St. and Superior Ave. A steam heating system will be installed in same. Total estimated cost, $3,000,000. Walker & Weeks, 1900 Euclid Ave., Arch.

Ohio, Cleveland—The Cleveland & Sandusky Brewing Co., American Trust Bldg., plans to construct a 2 story, 100 x 170 ft. bottling plant addition on East 55th St. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—The Cleveland Railway Co., Leader News Bldg., is receiving bids for the construction of a 5 story, 49 x 80 ft. sub station at 13006 Woodland Ave. A steam heating system will be installed in same. Total estimated cost, $50,000. C. H. Clark, Engr.

Ohio, Cleveland—The Federal Packing Co., East 4th St., plans to construct a 4 story, 40 x 115 ft. cold storage plant. Estimated cost, $100,000. Architect not selected

Ohio, Cleveland—The Greenlawn Realty Co., Society for Savings Bldg., plans to construct an 8 story, 100 x 200 ft. commercial building at 3208 Prospect Ave. A steam heating system will be installed in same. Total estimated cost, $500,000.

Ohio, Cleveland—G. W. Hale, Leader News Bldg., plans to construct a 6 story, 95 x 300 ft. commercial building on East 9th St. and Prospect Ave. A steam heating system will be installed in same. Total estimated cost, $125,000.

Ohio, Cleveland—L. W. Kelley, Hickox Bldg., to construct a 10 story, 148 x 220 ft. commercial building at 2425 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ohio, Cleveland—L. W. Kelley, Hickox Bldg plans to construct a 6 story, 80 x 200 ft. hotel on Euclid Ave. A steam heating sytem will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—The Kelly Springfield Tire Co., Prospect Ave., plans to construct a 5 story, 90 x 200 ft. sales building addition on East 46th St. and Prospect Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—The Lakeside Hospital Association, East 12th St. and Lakeside Ave., plans to construct a 12 story, 200 x 350 ft. hospital on University Circle. A steam heating system will be installed in same. Total estimated cost, $2,000,000.

Ohio, Cleveland—E. D. Latimer, 12037 Lake Ave., plans to construct a 7 story, 120 x 200 ft. commercial building on East 50th St. and Prospect Ave. A steam heating system will be installed in same. Total estimated cost, $200,000.

Ohio, Cleveland—Frank C. Newcomer, Citizens Bldg., plans to construct a 6 story, 100 x 125 ft. commercial building on Euclid Ave. and 86th St. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—The Paudett Investment Co., Citizens Bldg., plans to construct a 6 story, 94 x 122 ft. loft building at 1825 East 18th St. A steam heating system will be installed in same. Total estimated cost, $125,000.

Ohio, Cleveland—The Petrequin Paper Co., West 3rd St., plans to construct a 4 story, 120 x 200 ft. commercial building at East 48th St. and prospect Ave. a steam heating system will be installed in same. Total estimated cost, $120,000.

Ohio, Clevland—The Prame Realty Co., Williamson Bldg., plans to construct an 8 story, 100 x 200 ft. commercial building on Prospect Ave. A steam heating system will be installed in same. Total estimated cost, $500,000.

Ohio, Cleveland—The Western Electric Co., 413 Huron Rd., plans to construct a 6 story, 100 x 100 ft. warehouse and office building on Carnegie Ave. A steam heating system will be installed in same. Total estimated cost, $125,000.

Ohio, Cleveland—The White Motor Car Co., East 79th St., is having plans prepared for the construction of a 1 story, 200 x 600 ft. factory addition. A steam heating system will be installed in same. Total estimated cost, $600,000.

Ohio, Cleveland—The Zenith Tire & Rubber Co., Schofield Bldg., is having preliminary plans prepared for the construction of a 1 story factory on Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $10.000,000. A. W. Harris, Schofield Bldg., Arch.

Ohio, Cleveland Heights — (Warrensville P. O.) Israel & Makoff, 3533 Woodland Ave., plans to construct a 6 story 100 x 150 ft. theatre on Euclid Blvd. A steam heating system will be installed in same. Total estimated cost, $175,000.

Ohio, Urbana—The Urbana Packing Co. has awarded the contract for the construction of a 2 story, 30 x 75 and 30 x 60 ft. power house and storage plant, to J. A. Poss, Springfield. Estimated cost, $30,000.

Ind., Muncie—The Board of Commissioners, will receive bids October 11 for the erection and completion of power house and laundry, at the Delaware County Orphan's Home, here.

Mich., Adrian—Peter Dederick, Arch., 501 Chamber of Commerce, will soon award the contract for the construction of a 3 story, 69 x 136 ft. school, for St. Joseph's Academy. A steam heating system will be installed in same.

Mich., Bay City—The Board of Education is having plans prepared for the construction of a 3 story high school. on Columbus Ave. A steam heating system will be installed in same. Total estimated cost, $1.000,000. Pratt, Bickel & Campbell, 814 Tower Ct., and Perkins, Fellows & Hamilton, 514 Crapo Block, Chicago, Ill., Arch.

Mich., Caro—The Caro Water Co. plans to construct a pumping plant and storage reservoir. Estimated cost, $25,000.

Mich., Detroit—The Garfield Cartage Co., Harper Ave., is having plans prepared by A. G. Schutt, Engr., 1333 Book Bldg., for the construction of a 1 story, 30 x 70 ft. garage. A steam boiler for heating purposes will be installed in same.

Mich., Detroit—The General Ice Delivery Co., Grand River Ave., is having plans prepared for the construction of a 1 story, 36 x 322 ft. ice storage plant on Warren Ave. An electric motor for power and an ice handling conveyor will be installed in same. Dalton R. Wells, 435 Woodward Ave., Arch.

Mich., Detroit — Albert Kahn, Arch., Marquette Bldg., is receiving bids for the construction of a 1 story, 275 x 528 ft. automobile factory, for the Paige Detroit Motor Car Co McKinstry and Fort St. W. A steam heating system and electric motors for power will be installed in same.

Mich., Detroit—Albert Kahn, Arch., Marquette Bldg., is receiving bids for the construction of a 2 story, 60 x 100 ft. administration building on Wyoming and West Warren Ave., for the Detroit Seamless Steel Tube Co., 841 Jefferson Ave. W. A steam heating system will be installed in same. Total estimated cost, $70,000.

Mich., Detroit—J. Lawson Miller, Arch., 15 Goebel Bldg., is preparing plans for the construction of a 2 story, 43 x 100 ft. factory on Orleans St. and Milwaukee Ave. A steam heating boiler and electric motors for power will be installed in same. Total estimated cost, $35,000. Owner's name withheld.

Mich., Flint—Champion Ignition Co. will soon award the contract for the construction of a 3 story, 108 x 178 ft. factory, on Industrial Ave. and Harriet St. Steam heating equipment, boiler and accessories, mechanical conveyors, etc. will be installed in same.

Mich., Hamtramck—Raseman & Freier, Arch., 1302 Penobscot Bldg., Detroit, preparing plans for the construction of a 4 story, 100 x 200 ft. factory here. A steam heating plant will be installed in same. Total estimated cost, $200,000. Owner's name withheld.

Mich., Oakwood—The Board of Education plans to construct a school. A steam heating system will be installed in same. Total estimated cost, $230.000. Van Leyen, Schilling & Keough, Union Trust Bldg., Detroit, Arch.

Ill., Chicago—Balaban & Katz, 3535 West 12th St., are having preliminary plans prepared by C. W. and G. L. Lapp, Arch., 190 North State St., for the construction of a 2 story, 160 x 170 ft. theatre on State and Lake St. A steam heating system will be installed in same. Total estimated cost, $1,500,000.

Ill., Chicago—The B. P. O. Elks, E. P. Rupert, Arch., 154 West Randolph St., is having palns prepared for the construction of a 4 story, 60 x 120 ft. club house on South Side. A steam heating system will be installed in same. Total estimated cost, $125,000.

Ill., Chicago—G. C. Nimmons & Co., Arch., 122 South Michigan Ave., is receiving bids for the construction of a 5 story, 125 x 127 ft. addition to wall paper building, for the Sears Roebuck & Co., Harvard and Homan Ave. A steam heating system will be installed in same. Total estimated cost, $225,000.

Ill., Joliet—The Bnai Jacob Congregation is having plans prepared for the construction of a 1 story, 60 x 100 ft. synagogue on Lincoln St. A steam heating system will be installed in same. Total estimated cost, $100.000. D. S. Klafter, 64 West Randolph St., Chicago, Arch.

Wis., Elkhorn—The city will soon award the contract for excavating and laying 9610 ft. of 8-in. sewer, 1240 ft of 4-in. cast iron pipe, etc., and is in the market for sewage pumping machinery and other equipment. Total estimated cost, $30,000. A. C. Olsen, City Hall, Engr.

Wis., Hartford—The city is having plans prepared by Cahill-Douglas, Engr., Gross Bldg., Milwaukee, for the construction of a 1 story, 60 x 110 ft. power plant. A steam heating system and electric power will be installed in same. Total estimated cost between $50,000 and $60,000.

Wis., Milwaukee—Vaughn & Meyer, Security Bldg., is interested in manufacturers of gas engine economizers.

Minn., Biwabik—L. R. Christensen, Secy., Bd. Education, will receive bids until September 30, for the construction of a 2 story, 100 x 100 ft. addition to high school on Main St. A steam heating system will be installed in same. Total estimated cost, $100.000. C. E. Nystrom, Palladio Bldg., Duluth, Engr. and Arch.

Minn., Duluth—The Duluth Show Case Co., 2800 West Superior St., plans to build a 3 story, 75 x 280 ft. factory, on 49th Ave. W. A steam heating system will be installed in same. Total estimated cost, $175,000 Anthony Puck, Forrey Bldg., Engr. and Arch.

Minn., Minneapolis—B. N. Schneider, 232 Plymouth Bldg., is receiving bids for the construction of a 6 story, 122 x 178 ft. hotel and business house, on Franklin and Colfax St. Vapor heating system and elevators will be installed in same. Total estimated cost, $800,000. Frederick Van Antwerp, 240 LaSalle Bldg., Engr. and Arch.

Kas., Garden Plain—The city plans to construct an electric light plant. Estimated cost, $15,000. E. Behn, cl. W. B. Rollins & Co., 209 Railway Exchange, Kansas City, Mo., Engr.

Kan., Wichita—The Sisters of Charity will receive bids October 1 for the construction of a 2 story 57 x 90 auditorium, a 3 story 36 x 144 ft. dormitory and a 2 story 37 x 90 ft. chapel. Steam heating systems will be installed in same. Total estimated cost, $250,000. White & Dean, 30 Bellefontaine St., Kansas City, Mo., Arch.

Neb., Omaha—John Latenser & Sons, 632 Bee Bldg., will soon award the contract for the construction of a 6 story, 106 x 120 ft. hospital on 26th St. and Dewey Ave., for the Lister Hospital, 14th St. and Capital Ave., to include a power plant, generators and ice machine, etc. Total estimated cost, $300,000.

N. D., Halton—The city voted $10,500 bonds to improve and enlarge electric light plant.

Mo., St. Louis—The Liberty System Corporation, 2310 Locust St, plans to construct a 2 story, 65 x 450 ft. factory. A steam heating system will be installed in same. Total estimated cost, $145,000. P. J. Brahshaw, 722 Chestnut St., Arch.

Okla., Hockerville—The Aztec Mining Co. has leased the property of the old Lucky Strike Mine, whose mill was recently destroyed by fire, and plans to build a hand-jig plant on same. The company is in the market for boiler, hoist and hand-jigs. Harry Larsh, Mgr.

Okla., Muskogee—The Board of Education is having plans prepared for the construction of a 3 story, 100 x 120 ft. high school. A steam heating system will be installed in same. Total estimated cost, $230,000. H. O. Valeur & Co., 705 Phoenix Bldg., Arch.

Okla., Tulsa—The Board of Education is having plans prepared by G. W. Winkler, Arch., 414 Palace Bldg., for the construction of a 3 story, 125 x 260 ft. high school. A steam heating system will be installed in same. Total estimated cost, $350,000. Hedrick & Huff, Kansas City, Mo., Engr.

Col., Flagler—The Town Council will receive bids until September 29, for the construction of a waterworks system and pumping plant and is in the market for one 100,000 gal. tank on tower, 100 ft. to balcony. 2 deep well pump heads, 50 gal. per minute capacity, one 35 hp. oil engine, one 75 hp. oil engine, suitable generators for above engines. Total estimated cost, $60,000. R. D. Salisbury, 1415 East Colfax Ave., Engr.

N. M., Lurdsburg—The Bonney Consolidated Copper Co. plans to construct a new power plant. Semi Diesel or distillate engines, 400 hp. in 2 or 4 units, electrical geneators, triplex pump and compressors, etc. will be installed in same. Total estimated cost, $110,000. J. P. Portens, Supt.

Ore., Bend—The Bend Water, Light & Power Co. plans to construct a 1000 kw. steam plant to double present power output. Total estimated cost, $100,000. J. H. Foley, Bend, Mgr.

Ore., Portland—The Commission of Public Docks, foot of Stark St., will receive bids until September 25, for furnishing and delivering electrical equipment for charging storage battery trucks, at St. John's Terminal, Pier No. 1. Estimated cost $5000. G. B. Hegardt, c/o Public Docks Commission, Engr

Cal., Bakersfield—The Conklin-Brodek Estate, c/o Orville Clark, Arch., Bakersfield, is having plans prepared for the construction of a 3 story, 115 x 132 ft. store building, on 20th and Chester St. Cooling, heating and automatic sprinkler systems will be installed in same. Total estimated cost, $100,000.

Cal., Fillmore—The city plans election to vote on $20,000 bonds to construct an additional pumping plant, and extend distributing system.

Cal., Long Beach—The Board of Education received lowest bid for installing heating system in the proposed 2 story school on American Ave., from J. Hokom, 4312 Moneta Ave., Los Angeles, $12,248.

Cal., Long Beach—The Trident Packing Co., Long Beach, will take over the plant of the Pacific Packing Co. and plans to build a refrigeration plant and cold storage house addition to same. Total estimated cost, $50,000.

Cal., Los Angeles—The Board of Public Works will receive bids until October 6 for furnishing pumping equipment for the Manchester Avenue Sewage pumping plant. A. C. Hansen, City Engr.

Ont., Toronto—The William Davies Co., Ltd., 521 Front St., plans to construct a 3 story store and office building, on Front St A steam heating system will be installed in same. Total estimated cost, $150,000. Hynes, Feldman & Watson, McKennon Bldg., Arch.

Ont., Windsor—The Board of Education, LaBelle Bldg., will receive bids about September 24, for the construction of a 3 story, 215 x 230 ft. school on Giles Blvd. A steam heating system consisting of boiler, pump, motor and fan will be installed in same. Total estimated cost, $200,000. A. H. McPhail, Board of Trade Bldg., Arch.

Sask, Melville—The Grand Trunk Pacific RR., McGill St., Montreal, plans to erect an electric power plant here. Total estimated cost, $110,000. H. R. Safford, Ch. Engr.

CONTRACTS AWARDED

Mass., Lowell—Massachusetts Cotton Mills, Canal St., has awarded the contract for the construction of a water power plant, to the H. P. Cummings Construction Co., 14 Prospect St., Ware. Total estimated cost, $200,000.

Conn., Bridgeport—The Peoples Ice & Cold Storage Co., 1335 Seaview Ave., has awarded the contract for excavating and laying foundations for a 7 story 100 x 150 ft. cold storage plant and 1 story, 65 x 100 ft. and 60 x 65 ft. warehouse, on Seaview Ave., to T. J. Pardy Construction Co., 1487 Seaview Ave. Cost, $25,000. Total estimated cost, $350,000.

Conn., West Hartford—Sleeper & Parisi, 26 State St., Hartford, will hold two 6 story, 70 x 180 ft. apartment hotels, on Whitney Lane and Arnoldale Rd. A vapor heating system will be installed in same. Total estimated cost, $325,000. Work will be done by day labor.

N. Y., New York—J. P. Stanley, 30th St. and North River, has awarded the contract for altering and building a 3 story, 100 x 175 ft. addition to warehouse, to Fanning & Quinn, 105 West 40th St. A steam heating system will be installed in same. Total estimated cost, $100,000.

Md., Baltimore—The General Coffee & Tea Co., Light and Lee St., has awarded the contract for the construction of a 5 story, 83 x 197 ft. warehouse, to the West Construction Co., 907 American Bldg. Sub-bids will be received on steam heating, electric lighting and 2 electric elevators. Total estimated cost, $140,000.

Mich., Ecorse—The city has awarded the contract for furnishing and installing about 8000 ft. of water mains with hydrants, valves, etc., also 2 motor driven centrifugal pumps, 500 gallon per minute capacity, to T. C. Brooks & Son, West Grand Blvd., Detroit. Total estimated cost, $24,000.

Mich., Royal Oak—The Baker Land Co. has awarded the contract for the construction of a sewerage system, to include 2 motor driven centrifugal pumps, to Thorp & King, Royal Oak.

Mich., Ypsilanti—The Central Specialty Co., has awarded the contract for furnishing monorail equipment to the Sprague Electric Co., 40 Larned St., Detroit.

Ill., Chicago—The Quadrangle Club, Chicago University Campus, has awarded the contract for the construction of a 4 story, 60 x 140 ft. club house, to the C. Everett Clark Co., 69 West Washington St. A steam heating system will be installed in same. Total estimated cost, $225,000.

Ind., Fort Wayne—Thieme Brothers Co., Park Ave., has awarded the contract for the construction of a reinforced-concrete and steel factory on Runnion and Morrison Ave., to the Indiana Engineering & Construction Co., 528 Lincoln Life Bldg. A steam heating system will be installed in same. Total estimated cost, $185,000.

Ia., Des Moines—J. A. Wetmore, Supervising Architect, Treasury Department, Washington, D. C., has awarded the contract for repairing heating system in the old Post Office and Court House here, to the Bailey Plumbing Co., 404 West Grand Ave.

Kan., Manhattan—State Board of Administration, Topeka, has awarded the contract for heating system, to be installed in proposed 3 story, 50 x 112 ft., and 22 x 56 ft. engineering building here, to Miner D. Woodling, 512 Reliance Bldg., Kansas City, Mo. Estimated cost, $6152.

Mo., St. Louis—The St. Louis Independent Packing Co., 3815 Chouteau St., has awarded the contract for the construction of a 4 story 100 x 150 ft. by-product manufacturing plant on Vandeventer and Chouteau St., to A. H. Haeseler, Wainwright Bldg., St. Louis. Boilers, dryers and other equipment will be installed in same. Total estimated cost, $55,000.

Okla., Altus—The city has awarded the contract for improving of water works system, including installation of pumping machinery, to Maney Brothers, 304 Empire Bldg., Oklahoma. Total estimated cost, $62,500.

Okla., Oklahoma—The Mideke Supply Co., 200 West 1st St., has awarded the contract for the construction of a 3 story, 80 x 140 ft. main building and a 1 story, 75 x 140 ft. warehouse, to Reinhart & Donovan, Insurance Bldg. A steam heating system will be installed in same. Total estimated cost, $115,000.

Cal., Los Angeles—Paul Studios, Inc., Hollywood, has awarded the contract to Emil Fossler, 6434 Hollywood Blvd., for the construction of a motion picture studio on 20 acre site on Melrose and Crescent Ave., to consist of group of buildings to accommodate 30 producing companies, and central plant to serve all companies, including laboratories, one 100 x 480 ft. stage and three 100 x 350 ft. stages etc. Total estimated cost, including equipment, $1,500,000.

Cal., Willows—The city has awarded the contract for installing pump and motor, in Sewer District No. 2, to the California Hydraulic Engineering Co., 70 Fremont St., San Francisco, $914.

N. B., St. John—The city has awarded the contract for installing plumbing and heating systems, in connection with the proposed nurses home addition to the General Public Hospital, to R. E. Fitzgerald, St. Johns. Estimated cost, $15,780.

Ont., Port Arthur—The Canadian National Railways, Toronto, has awarded the contract for the construction of a 700,000 bu. grain elevator, to Barnett & McQueen, Port Arthur. Electric operated bucket conveyors will be installed in same. Total estimated cost, $600,000.

Ont., Walkerville—Essex Border Utilities Commission, Windsor, has awarded the contract for the construction of a sewage pumping staion here, to R. Westcott & Co., 39 Quellette Ave., Windsor. Estimated cost, $13,000.

A Personal Want—
can invariably be filled by a friend.

A Business Want—
must be satisfied by someone in your industry.

The Searchlight Section of this issue covers the
current business wants of the machinery field

SEE PAGES 79 to 87 "Think SEARCHLIGHT First" SEE PAGES 79 to 89

POWER

Volume 50 New York, September 30, 1919 Number 14

Industrial Relations

The present industrial unrest has been precipitated largely by two factors — an attempt to compel collective bargaining, and the high cost of living — but underlying the whole movement is a force working toward readjustment of industrial relations.

Labor, having been denied in the past what it considered its rightful share in the fruits of industry, has taken advantage of conditions created by the war and, conscious of its strength, is now asserting itself.

Capital has found it easier to meet Labor's demands and pass the burden on to the consumer without getting at the root of the problem, with the result that the situation has become aggravated instead of better.

The problem is so complex as to almost defy solution, but certain conditions exist that must be wiped out before any progress can be made. Among these are:

The supposed law of supply and demand has fallen down, because

1. There is profiteering on the part of both Capital and Labor.

2. There are indications of attempts by Capital and Labor to limit production.

But rectifying these conditions will not alone effect a solution; certain fundamentals must be recognized by both sides.

1. In the final analysis all wealth is the product of labor, but not of manual labor alone, as is mistakenly argued by one class. The trouble has been in evaluating, respectively, labor of the hands and of the brain.

2. It is not enough to say that Capital and Labor are partners. Labor must be shown.

3. Management must not assume that it is accountable to Capital alone, and it can no longer regard labor as a commodity to be bought and sold.

4. On the other hand, Labor must be shown that its demands must not be such as to stifle the very industry upon which it is dependent for its livelihood.

5. Both Capital and Labor are responsible to the public.

With these facts in mind the speediest relief may be expected through increased production with Labor assured of an adequate wage, legitimate Capital a fair return, and initiative a reasonable profit.

LARGE GOVERNMENT STORAGE PLANT FOR CHICAGO

Substantial construction, heavily insulated, with daily storage capacity exceeding 58 million pounds. Complete refrigerating and ice-making plants featured by the use of synchronous motors driving by belt two boosters and three high-pressure machines with aggregate capacity of 1005 tons of refrigeration on zero back-pressure basis.

STORING frozen meat for the army and making ice to ship it are the services required of the new Government cold-storage warehouse located in the Central Manufacturing District at Hoyne Ave. and Thirty-ninth St., Chicago. Over 58,000,000 lb. of meat can be stored at one time, and more than this amount can be frozen and shipped each month. In this same locality are numerous storage depots, some temporary and others of permanent character, which the Government erected during the war. The last building to be completed is the new cold-storage warehouse, which is one of the largest and most attractive in the country. It was erected at a cost of $2,150,000, not including the land. The entire refrigerating equipment cost $900,000, so that the total cost, excluding real estate, exceeded $3,000,000. The original proposal was made in July, 1918. Work started on July 25, occupancy of the basement for storage began Jan. 20, 1919, and on Mar. 15 of this year the building was occupied for freezing purposes.

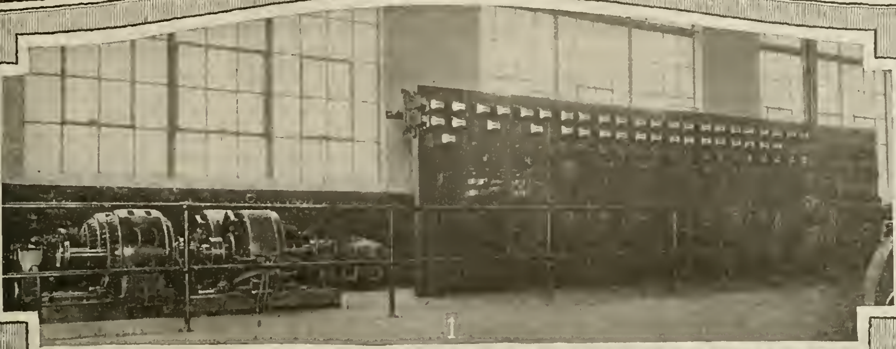
The building is a reinforced-concrete structure, six stories and basement, faced with red brick and trimmed with terra cotta, with a two-story wing addition in the rear for the ice plant and the refrigerating machinery. The main structure is 223 ft. wide by 323 ft. deep, the two-story and basement wing measuring 143 x 145 ft. There are also train sheds and unloading platforms with capacity for 50 cars at one setting. Including the additions last mentioned the total area of the building is approximately 586,000 sq.ft. and the volume 8,600,000 cu.ft. The total storage capacity approximates 58,250,000 lb. distributed as follows: 26,250,000 lb. to storage freezers, 8,000,000 lb. to sharp freezers and 24,000,000 lb. to ordinary storage. In general each of the six main floors is divided into four sections, a storage freezer being located at either end with two sharp freezer sections at the center. Cooling is effected by a direct-expansion ammonia system containing 800,000 lin.ft. of 2-in. pipe. In the storage freezers a minimum temperature of 10 to 15 deg. above zero is maintained by one lineal foot of piping to 18 cu.ft. of volume. In the sharp freezers, with temperatures ranging from 10 to 15 deg. below zero, the ratio is 1 to 3.

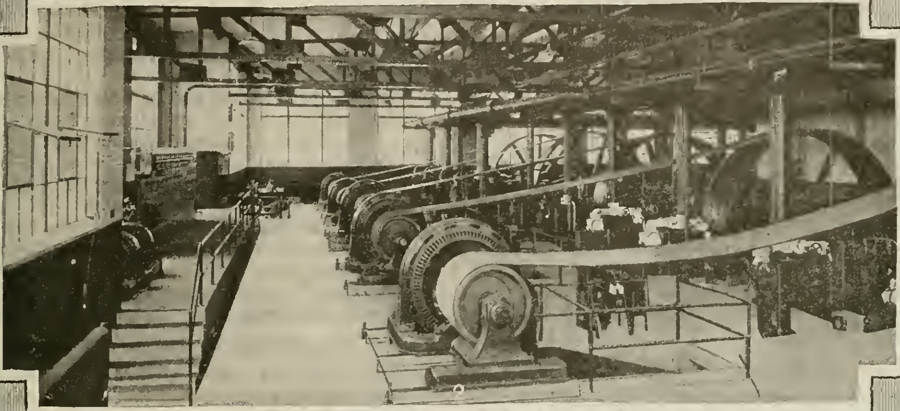
There are railway tracks on either side of the building. On one side cars are unloaded into storage and on the other side loaded from storage, so that there need be no conflict between the two operations. On each side there are four electric freight elevators of the worm-and-gear drum type, each having a car platform 9.5 by 13 ft. and a capacity of 6000 lb. The car contains 32 lin. ft. of track with hanging capacity for 4000 lb. of beef in quarters, and on the basis of eight trips per hour will carry 16 tons of meat. These elevators are spaced symmetrically with respect to the sharp freezer rooms, being located across the vestibules serving them. A complete interconnecting trolley track layout for all floors except the basement facilitates the handling and storing of the meat.

CORK-BOARD INSULATION OF STORAGE SPACE

To insulate the storage space the enormous quantity of 1250 tons of cork board was used. In the main building the first and fourth floors are insulated by 6 in. of cork in two 3-in. layers and the roof by 8 in. of cork in two 4-in. layers. The outside walls are insulated with 6 in. of cork in two 3-in. layers and the dividing walls between the freezer storage and sharp freezer rooms have 4 in. of cork in two 2-in. layers. At the first and fourth floors the columns were insulated with cork to a height of 5 ft. 6 in. and 3 ft. respectively, and in the basement column heads were insulated also with cork.

All exposed cork surfaces were plastered with cement mortar. The floor insulation was set in hot asphalt throughout. To apply the insulation to the walls, the first layer of cork was set in cement mortar and the second layer was set in hot asphalt and secured





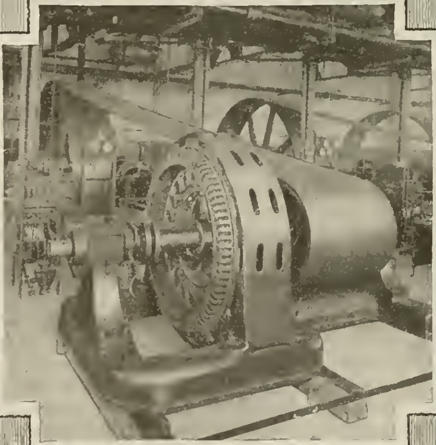


Fig. 1.—Switchboard and Motor-generator Exciter Sets. Fig. 2.—Compressor Room of Warehouse. Fig. 3.—Ammonia Pump-out Machine and Water Pumps. Fig. 4.—Close-up View of One of the Large High-Pressure Units Showing Starting Equipment and Synchronous Motor.

to the first layer by hickory dowel pins. The insulation is heavier than usual and the construction thoroughly good all the way through. It is evident that the Government has a substantial, convenient and highly efficient cold-storage warehouse.

The refrigerating plant is at the rear of the two-story wing previously mentioned. Originally, four high-pressure machines were specified, but owing to the reduction in service that would be needed on account of the cessation of the war, the fourth machine was omitted. The plant now contains three compressor units and two boosters having an aggregate capacity of 1005 tons of refrigeration. The compressors are of the horizontal, twin, double-acting type, with cylinders 17 x 36 in. Between the two compressors comprising the unit is a 15-ton flywheel, 18 ft. diameter and 43-in. face, serving as a belt pulley. The boosters are also of the twin type, with cylinders 30 x 42 in., having a displacement of 34.05 cu.ft., or 68.10 cu.ft. for the unit, per revolution. Each booster unit is served by a 12-ton flywheel 18 ft. in diameter and 32-in. face.

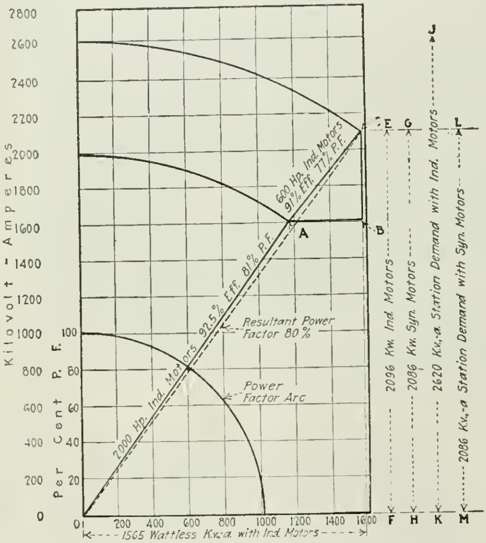


FIG. 5. VECTOR DIAGRAM COMPARISON OF INDUCTION AND SYNCHRONOUS MOTOR DRIVE.

Ammonia vapor from the house comes to the boosters at a pressure close to atmospheric, is delivered to the high-pressure machines at about 20 lb. and discharged to the condenser at the pressure required by the service (usually 150 to 175 pounds).

In choosing between steam and electric drive there were several features favoring the adoption of the latter. During the war it was difficult to obtain prompt delivery of steam-generating equipment. Time was an important element. The period during which maximum cold-storage service would be required was uncertain. The steam plant of the Central District was available to supply steam to the 7100 sq.ft. of direct radiation installed to heat the compressor room, offices, etc. Current at a low rate was available from the Produce Terminals Corporation in the U. S. yards near-by, and service could be installed readily. Electric service was the decision, and the next step was to choose between induction and synchronous motors for driving the compressors.

In this connection the relative comparison made in vector diagram form may be of interest. Originally, there were to be four high-pressure machines and two boosters, so that the comparison was made on this basis. The general results, however, will apply proportionately to the present installation. With the total refrigerating capacity divided up sufficiently, there was no need for variation in speed to meet changes in load. Units could be thrown on or off as the requirements demanded, and particularly in work of this character, as the variations easily could be foreseen.

For the high-pressure machines motors of 500-hp. capacity were required and 300-hp. motors for the boosters. These ratings are based on a 30-deg. temperature rise. The motors will carry a continuous overload of 25 per cent. at a 50-deg. rise, or 650 and 375 hp., respectively. Fig. 5 shows the vector diagram comparison of the kilovolt-ampere and kilowatt station demands when using four 500-hp. and two 300-hp. slip-ring induction motors, or the same number and size of synchronous motors of the self-starting, self-synchronizing type.

The 500-hp. induction motors were credited with an efficiency of 92½ per cent. and a power factor of 81 per cent. The line *O A*, drawn through a point corresponding to 81 per cent. on the power-factor arc and to a length determined by the kilovolt-ampere input to these four motors, indicates approximately 1980 kilovolt-amperes. To this load is to be added the two 300-hp. induction motors having an efficiency of 91 per cent. and a power factor of 77 per cent., giving final resultant kilovolt-amperage, indicated by the line *O C*, of 2620 and a resultant power factor of 80 per cent.

SYNCHRONOUS MOTORS WERE SELECTED

The synchronous motors will operate continuously at 100 per cent. power-factor, so that the kilovolt-ampere demand on the station is equal to the kilowatt demand. The latter may be figured readily from the efficiencies of the motors, the 500-hp. motors having an efficiency of 94 per cent. and the 300-hp. motors an efficiency of 93.6 per cent.

When using induction motors the kilovolt-ampere demand on the station is represented by the line *O C* in the diagram, which is equal to the line *J K*, or 2620 kv.-a. The kilovolt-ampere demand when using synchronous motors is equal to the line *L M*, or 2086 kv.-a. Considering the power factor in each case, the kilowatt demand would have been 2096 and 2086 kw. respectively, giving a difference of 10 kw. per hour in favor of the synchronous motors. Figured at 1c. per kw.-hr., this means a saving of 10c. per hour in actual energy consumption by using the synchronous motors. In addition the line *O D* shows that with induction motors there would be a 1565 wattless kv.-a. demand on the station. Owing to the synchronous motors operating at 100 per cent. power factor, the wattless kilovolt-ampere demand on the station would be zero.

With a station demand of 2620 kv.-a. when using induction motors and 2086 kv-a. with synchronous motors, there is a saving of 534 kv.-a station demand in favor of the latter. In other words, the central station capacity required by the induction motors would be 25.6 per cent. greater than with the same capacity in synchronous motors. To offset this advantage somewhat, the initial cost of the synchronous motors is greater.

For the present installation synchronous motors were selected of the size indicated previously. The operation has been entirely satisfactory, and by using the bypass on the compressors, there has been no difficulty in starting. At this period the characteristics of the synchronous motor are those of the induction motor, so that the operations are practically the same as with a motor of the latter type.

Three-phase 60-cycle current at 2200 volts, or line voltage, is taken by the motors. The speed of the motors is 360 r.p.m. and of the compressors 70 r.p.m. Connection between the two machines is effected by a three-ply 42-in. leather belt on 35-ft. centers. The motor speed of the boosters is the same and the compressor speed 60 r.p.m. The driving belt is 30 in. wide and 36 ft. between centers.

PRINCIPAL EQUIPMENT OF GOVERNMENT COLD-STORAGE WAREHOUSE

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
3	Compressors	Twin double-acting	17x36-in.	Refrigerating plant	Motor-driven, 70 r.p.m.	Ice and Cold Machine Co.
3	Motors	Synchronous	500-hp	Drive compressors	3-phase, 60-cycle, 2200-volt, 360 r.p.m	Electric Machinery Co
2	Compressors	Twin, double-acting	30x42-in	Boosters	Motor-driven, 60 r.p.m	Ice and Cold Machine Co.
2	Motors	Synchronous	300-hp	Drive boosters	3-phase, 60-cycle, 220-volt, 360 r.p.m	Electric Machinery Co.
2	Exciter sets	Syn.-motor-driven	50-kw	Excite syn. motors	75-hp. motor, 1200 r.p.m	Electric Machinery Co.
1	Condenser	Atmospheric	90 stands, 21 pipes high	Condenser ammonia vapor		Ice and Cold Machine Co.
1	Cooling tower	Natural ventilation	3,000-g.p.m	Cool condenser water		Water Cooling Equipment Co.
3	Pumps	Single-stage cent.	1,000-g.p.m	Circulate condenser water	Driven by Westinghouse 30-hp. ind. motor	Lea-Courtenay Co.
1	Pumpout mach.	2-cyl. vertical	9x9-in., 15 ton	Pump ammonia from system	Driven by G. E. 16-hp. ind motor	Frick Co.
1	Ice plant	Raw-water can	150-ton	Ice for refrig. cars	Direct exp. coils in brine	Ice and Cold Machine Co.

Union Insulating Co., cork; 2 Curtis motor-operated ice cranes; Ball can dumps; Ball thawing tubs; Burns can fillers.

Excitation is effected by two synchronous motor-generator sets consisting of a 75-hp. motor and a 50-kw. 125-volt direct-current generator. Either set will supply sufficient excitation current for the five large motors in the station and for its own driving motor. Other motors of the station for driving the elevators, ammonia pump-out machine and condenser circulating pumps are of the 220-volt induction type. Lighting is effected by three-wire 110-220-volt single-phase distribution.

On the roof over the central portion of the compressor room the ammonia condenser is housed in louver construction. It is of the atmospheric, continuous-flow, flooded type consisting of 90 stands 21 pipes high. Water for cooling comes from the cooling tower located over the ice plant and at a higher elevation. It is of wood and steel construction, with natural ventilation, and has a capacity of 3000 gal. per min. From the condenser pan the cooling water enters the suction of motor-driven single-stage centrifugal pumps located on the compressor-room floor and is elevated to the top of the cooling tower. The head against which the pumps operate, however, is the difference between the two water columns plus the friction in the piping. There are three pumps, each of 1000 gal. per min. capacity and driven by a 30-hp. induction motor. Two pumps handle the service, leaving one as a spare.

ONE HUNDRED AND FIFTY TON ICE PLANT

To furnish ice for refrigerator cars and other purposes, a 150-ton plant was provided. It contains the complete equipment for two tanks, one for the manufacture of clear ice and the other for making opaque ice. Each tank is 68 ft. long, 36 ft. wide and 60 in. deep, and the two tanks contain a total of 1820 cans of the 400-lb. size. A temperature of approximately 15 deg. F. is maintained in the tanks by direct-expansion coils immersed in brine. Circulation is effected by two propellers per tank of the vertical type direct-connected to motors. Each tank is provided with a motor-operated ice crane, and there are suitable can dumps, thawing tubs and can fillers. Raw water from the city mains is frozen. An 8-in. line from the service tunnel is capable of delivering 250,000 gal. per day, this quantity being adequate to meet the needs of the refrigerating and ice-making plants and of the main building. For the clear ice, agitation is effected by compressed air supplied by a motor-driven compressor in the engine room.

In connection with the ice plant there is storage capacity of 5000 tons. The storage rooms extend through two stories, occupying space between the compressor room and the main building. The plan area of the reserve storage is 6045 sq.ft. and the volume 175,305 cu.ft. Immediately above is the daily ice-storage room having an area of 4595 sq.ft. and a content of 59,103 cu.ft. The ice-making room is at the same level and adjoining the daily storage, while the reserve storage extends downward to the main floor to give convenient access for icing the cars.

Plans were prepared for the Central Manufacturing District, contractor, by S. Scott Joy, architect, who retained Henschien & MacLaren, of Chicago, as consulting engineers. The Government was represented during the construction by Major S. L. Nelson, constructing quartermaster; S. F. Forbes, supervising engineer, and Gardner and Lindberg, supervising architects. The plant has been leased by the Government to the United States Cold Storage Co., with C D. Allman, general superintendent, and F. J. Roose, chief engineer, in charge of operations.

A Practical Method of Checking Watt-Hour Meter Connections

By E. A. Fischer

Two-wire watt-hour meters, either direct current or single-phase alternating current, can be connected in but two ways—either to run forward or backward. Sometimes the direction of rotation is unknown and the proper rotation must be determined in order to have the correct registration. This may be easily determined by disconnecting the register and by turning it and noting the direction of rotation of the gear engaging the shaft of the rotating element; when the pointers are traveling in the right direction, the rotating element must run in such direction.

In computing the size of feed pipe for a boiler provision should be made for a capacity of twice that required at its normal rating, and proportion the pipe for a velocity of about 100 feet per minute for sizes ranging from 1 to 2-inches.

The Relation of Time of Ignition to the Economy of the Gasoline Engine

By J. P. CALDERWOOD* and A. J. MACK†

PRACTICE has more or less standardized the time of ignition in the operation of stationary gasoline engines, yet there may be certain advantages gained by changing the point of ignition beyond that fixed by precedent. Whether or not the economy would be improved by increasing the spark angle is a question that could logically be asked, but the direct answer, if reasonably accurate, is difficult because of the many variables that enter.

Based upon the theoretical cycle, varying the time of ignition beyond that of dead-center plays little or no part in increasing the economy of the engine. The Otto cycle, as the reader will recall, is made up essentially of two constant volume and two adiabatic curves. The cycle in its theoretical operation requires what might be termed a perfectly combustible gas—one that, when ignited, burns immediately, producing the constant volume expansion or explosion curve of the Otto cycle. The time of the spark in such a case is at dead-center, and as soon as ignition takes place the function of the spark is complete. Advancing the spark would tend to retard the engine, while retarding the spark to a point where ignition occurred after dead-center had been reached would in like manner cause a loss of power and economy. Consequently, theory indicates that advancing or retarding the spark would produce a decrease in economy.

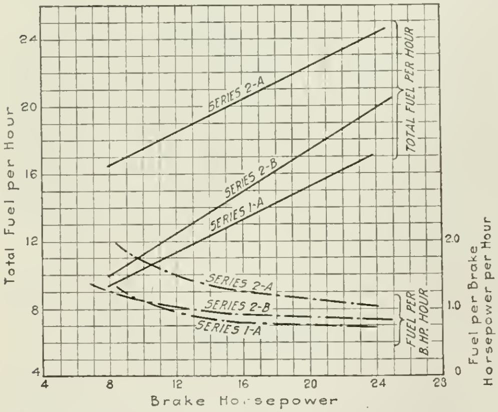


FIG. 1. RESULTS OF TESTS TO DETERMINE THE EFFECT OF SPARK ADVANCE UPON THE ECONOMY OF A THROTTLE-GOVERNED GASOLINE ENGINE

However, this theory may be in error when applied to the practical cycle. The gasoline engine does not utilize a perfectly combustible gas. As a result an appreciable period of time is required for the explosion. Consequently, to approach the constant volume explosion curve of the theoretical cycle, the time of ignition must be advanced beyond that of dead-center.

Since ignition of the charge before reaching dead-center is necessary because of the slower-burning or explosion properties of gasoline vapors, it may be reasoned that when once adjusted and the engine operated at normal speed no alteration in the spark would be necessary. This reasoning is sound, and if it were true would simplify gasoline-engine operation. However, the rate of flame propagation of gasoline vapor does not remain constant with the result that the time of ignition must be changed to suit. It is this fact that often complicates any theoretical discussion of the effects that may be expected from altering the time of ignition.

RESULTS OBTAINED FROM THE TESTS

Run Number	Revolutions per Minute	Brake Horsepower	Pounds of Fuel Used per Hour Total	Pounds of Fuel Used per Hour Per B. Hp.	Per Cent. Thermal Efficiency Based on B. Hp.
		Series 1-A			
9	266.8	23.97	17.0	0.710	17.7
10	284.2	19.25	15.0	0.787	16.0
7	277.0	19.20	14.5	0.755	16.8
11	287.7	13.00	12.5	0.962	13.1
4	282.1	8.34	9.2	1.110	11.3
		Series 2-A			
1	266.5	24.70	24.5	0.99	12.7
2	279.0	19.40	22.5	1.16	10.9
3	285.0	14.75	18.5	1.25	10.1
		Series 2-B			
61	272.3	25.14	20.5	0.817	15.5
62	283.0	19.58	17.0	0.871	14.5
63	286.0	13.33	12.3	0.924	13.7
64	287.6	6.64	9.2	1.38	9.1

Just what conditions alter the flame-propagating qualities of gasoline vapor is perhaps not fully understood, but tests seem to indicate that it is a function of the temperature and quality of the mixture. With constant fuel mixture, the flame propagation is increased by increasing the pressure at the end of the compression stroke, by increasing the temperature of the jacket water, by increasing the temperature of the inlet mixture, and by decreasing the speed of the engine; while with variable fuel mixtures high flame propagation is especially pronounced with leaner mixtures, gradually decreasing as the mixture becomes richer. These facts introduce so many variables in the operation of the gasoline engine that to advance a reasonably accurate opinion as to the effect of time of ignition would be difficult.

Tests by the Engineering Experiment Station of the Kansas State Agricultural College

In order to study the effect of spark advance upon the economy of the gasoline engine, a rather extensive series of tests has been conducted by the Engineering Experiment Station of the Kansas State Agricultural College. These tests were conducted upon a 25-hp., four-stroke-cycle horizontal gas engine. The engine was equipped with a throttling governor and the ignition accomplished by means of a wipe spark.

During the test all conditions, such as temperature of the jacket water and speed of the machine, which would change the flame propagation of the fuel, were maintained as nearly constant as possible. In each series of tests the only variable was that of load, and great care was exercised to secure identical fuel for all tests.

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*Professor of Steam and Gas Engineering, Kansas State Agricultural College.

†Instructor in Steam and Gas Engineering, Kansas State Agricultural College.

The investigation included many tests and a great quantity of data was secured, but for the purpose of this discussion may be reduced to three series.

Series 1-*A* was conducted to determine the fuel economy of the engine when operating at various loads with the carburetor so adjusted as to give an economical mixture and the maximum load with a constant spark advance of about 30 deg. No alterations in the setting of the carburetor were made during the test, the governor being entirely relied upon for speed regulation.

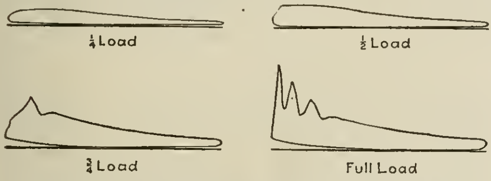


FIG. 2. INDICATOR DIAGRAMS FROM THROTTLE-GOVERNED GASOLINE ENGINE, SHOWING DEVIATION FROM THE CONSTANT VOLUME EXPLOSION AT VARIOUS LOADS

Series 2-*A* was conducted under the same conditions as Series 1-*A*, with the exception that the carburetor was so adjusted as to produce a rich fuel mixture. This series is directly comparable with Series 1-*A* and shows the effect of poor carburetor adjustment upon the economy.

Series 2-*B* was conducted under the same conditions as Series 2-*A*, but with the spark advanced to an angle of 42 deg. This setting of the spark resulted in the maximum load for that adjustment of the carburetor. This series is comparable with Series 1-*A* in that it shows the relation between the economy, power and spark advance for two settings of the carburetor.

The principal results obtained from these tests are given in the table and are graphically represented in Fig. 1.

RESULTS OF TESTS CONFORM WITH THOSE PREDICTED

The results of these tests conform with those that were predicted from theory. Spark advance above that nominally carried produces no increase in economy of the engine. For each condition of fuel mixture, temperature of jacket water and other factors that influence the flame-propagating qualities of the gasoline vapors a certain definite time of ignition is necessary to produce the desired explosion. Ignition above this point produces preignition or pound, while ignition below produces a gradual decrease in the speed of the engine.

This investigation has pointed out several rather important functions of the spark as follows:

1. With other conditions constant the economical spark advance to be carried depends upon the fuel mixture. With richer mixtures higher spark advance may be utilized.

2. With a richer mixture and higher spark advance the maximum delivered horsepower will be greater than can be secured with leaner mixtures and smaller spark advance. This statement does not contemplate, however, the use of fuel mixtures so rich that incomplete combustion may result. The economy will probably decrease as the richness of the fuel mixture increases.

3. The fuel economy of the gasoline engine depends very largely upon the carburetor setting, but the poorer economy due to improper carburetor adjustment can be largely corrected by altering the position of the spark. Thus if a carburetor produces too rich a mixture, advancing the spark until the combustion or explosion curve is vertical will result in practically the same economy as will be obtained with a proper carburetor adjustment and smaller spark advance.

4. The economy of the throttle-governed engine can be improved by the use of a variable spark advance, especially upon those engines that are operated under variable loads. How this theory may be applied to the throttle-governed gasoline engine can best be explained by considering the action of the governor.

With the throttle governor the proportion of the air to gas mixture remains theoretically constant, while the quantity of the mixture admitted per cycle is varied to suit the power demand. This is accomplished by throttling the fuel charge during the entire suction stroke, thus reducing the pressure of the entering gas and regulating the amount of the charge admitted. With this type of governor the reduction in the amount of the mixture results in the lowering of the compression curve at all loads except at maximum or full load, when the governing valve would be entirely open.

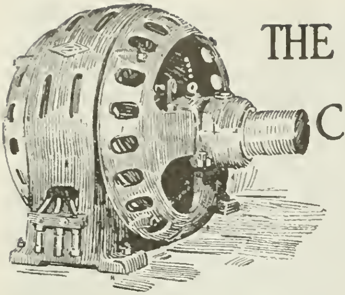
LOWERING COMPRESSION CURVE LOWERS PRESSURE AND TEMPERATURE OF FUEL MIXTURE.

The lowering of the compression curve lowers the pressure and temperature of the fuel mixture at the firing period. With constant spark advance for all loads, which is usually the case in stationary gasoline-engine practice, the flame propagation of the mixture varies as the delivered power diminishes, and as a result, through no fault of the governor, the degree of economy needlessly decreases at the lighter loads. Variations in the flame propagation for the various loads are noticeable from the indicator cards shown in Fig. 2. The effect upon the economy is slight between full and three-quarter loads, but increases rapidly beyond that point.

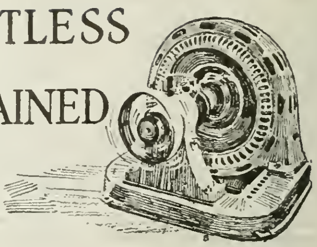
To take advantage of this fact, the degree of spark advance would have to be greater than is now possible with most engines. About the maximum range in spark control is 30 deg., and this limits the advance to that point since zero spark advance is advisable in starting. If the best economy at all loads of throttle-governed engines is to be secured by altering the time of ignition, the maximum throw of the spark should be greater than 30 deg. A zero spark angle should be provided for starting, about a 30-deg. angle for full load, while a 50- or 60-deg. angle should be provided for lighter loads.

It is comparatively easy for the operator to judge when the spark conditions are such as to produce the best economy. The spark should be advanced until a slight pound due to the rapid burning of the fuel charge is heard, then the spark should be slightly retarded until this pound just disappears.

The regulation of the spark could be made automatic by connection to the governor. At the lighter loads the speed of the engine and consequently the governor is perceptibly increased, and this change in speed could be utilized in adjusting the spark. However, few of the stationary gasoline engines are so equipped.



THE FLOW OF WATTLESS CURRENT EXPLAINED



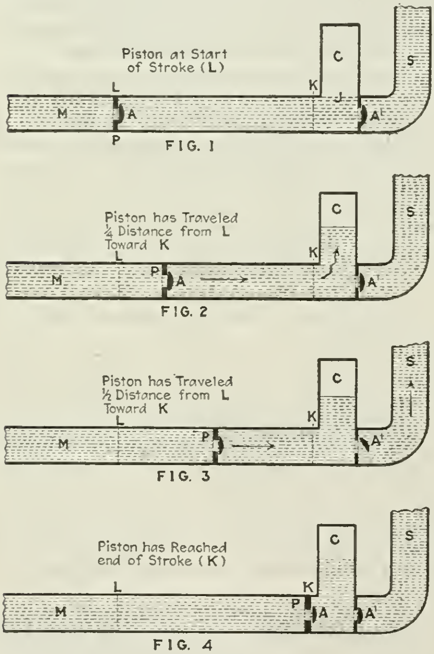
By

Will Brown*

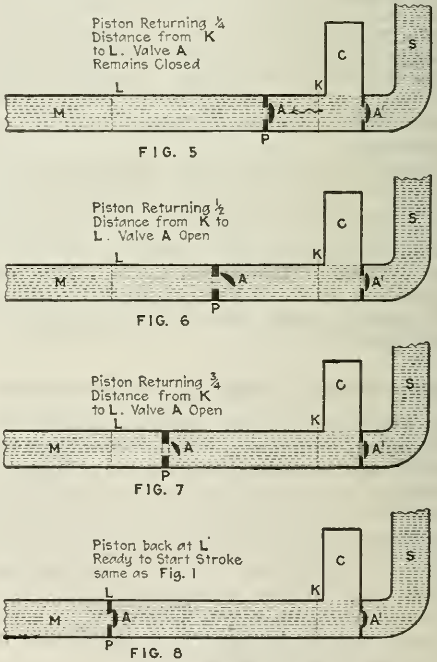
Just what a synchronous motor does when correcting power factor is made plain by a comparison with the action of water in a pipe, where pressure corresponds to voltage and flow of water to amperes.

NO SOONER do we start to discuss synchronous motors than we raise the bogy of power factor and the flow of wattless current. To be sure, the synchronous motor is a mechanical machine to do work—quite similar in many ways to an induction motor—but it has one great electrical advantage that no induction motor can ever possess, namely, its power factor can be controlled.

Power factor of alternating-current circuits has always been a difficult thing for those with a limited technical training to understand. It is easy to dismiss it with an offhand comparison or to give a technical definition, but the trouble is, these do not really explain. Almost everyone can understand the action of water in a pipe, where pressure corresponds to voltage and flow of water (gallons per minute) corresponds to current (amperes).


Piston at Start of Stroke (L)
L
K
C
J
S
M
A
A'
P
FIG. 1
Piston has Traveled ¼ Distance from L Toward K
FIG. 2
Piston has Traveled ½ Distance from L Toward K
FIG. 3
Piston has Reached end of Stroke (K)
FIG. 4

FIGS. 1 TO 4. SHOW PISTON AND FLOW OF WATER ON FORWARD STROKE


Piston Returning ¼ Distance from K to L. Valve A Remains Closed
L
K
C
S
M
A
A'
P
FIG. 5
Piston Returning ½ Distance from K to L. Valve A Open
FIG. 6
Piston Returning ¾ Distance from K to L. Valve A Open
FIG. 7
Piston back at L Ready to Start Stroke same as Fig. 1
FIG. 8

FIGS. 5 TO 8. SHOW PISTON AND FLOW OF WATER ON RETURN STROKE

Let us examine the diagrams, Figs. 1 to 8, which represent sectional views of a water pipe and piston pump. Here P is a piston which travels forward and back in pipe M, between the points L and K, representing the starting point and end of each stroke; A is a valve in the piston, A' is a valve leading to the discharge pipe S, C is an air chamber, and J is the level of the water in the air chamber when the piston is not exerting pressure. There is a constant supply of water in the pipe *M* which maintains a normal level at *J*. The piston *P* travels forward and back between points *L* and *K*. Valve *A* closes under pressure when the piston is moving toward *K*. Valve *A′* opens when the pressure from the left becomes greater than the pressure from the right.

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*Engineer with the Electric Machinery Company.

There is a constant pressure in the discharge of pipe *S* due to the head. When piston *P* travels forward from *L* to *K*, it forces the water ahead of it. Water is not compressible and must find a place to go. The arrows indicate the flow of water, solid arrows showing effective flow and wavy arrows reactive flow. Since there is a pressure in the discharge pipe *S* greater than the air pressure in *C*, valve *A′* will stay closed and the water will be forced up into chamber *C*, until the pressure of the air thus compressed equals the pressure of *S*. Then valve *A′* will open, and the rest of the water will be forced out through discharge pipe *S*.

When the piston stops at *K* (end of stroke), there is no longer any force driving the water forward, ignoring the momentum. Pressure in *S* then closes valve *A′*, and pressure in *C* helps to force the piston backward on its return stroke. Valve *A* remains closed on the return stroke until the water in *C* drops to its former level, when valve *A* opens and allows the piston to continue back to *L* while a fresh supply of water enters the pump.

Let us assume that one-fourth of the volume of water in the pump (from *L* to *K*) is forced up in chamber *C* at each forward stroke and returns again into the pump at each backward stroke. The pump therefore delivers only three-fourths of its capacity to the discharge pipe *S*. In other words, the pump is running at 75 per cent. power factor. No actual power is consumed by forcing the water into chamber *C* for the reason that an equal amount of power is returned to the piston on the return stroke.

Pressure in the pump corresponds to voltage in an electric circuit; flow of water through the pipe corresponds to current. It is plain to be seen that no water begins to flow in the discharge pipe *S* until the pressure on valve *A′* has increased from zero to a point equal to the pressure of the head. In other words, the flow lags behind the pressure just as the current lags behind the voltage in an inductive alternating-current circuit.

The volume of water moved, at the pressure maintained, while the piston is traveling from *L* to *K*, corresponds to apparent power (kv.-a). The volume of water forced at the pressure maintained through the discharge pipe *S* corresponds to real power (kw.). The water that flows up and down in chamber *C* corresponds to reactive, or wattless, current. If chamber *C* is closed, there will be no reactive current and the full capacity of the pump will be delivered at each stroke; or, in other words, the pump will operate at 100 per cent. power factor.

While the foregoing is a good hydraulic explanation of lagging power factor, where current lags behind voltage, there is no exact analogy for leading power factor, where current leads the voltage. But suppose we imagine a gas that has a quality exactly opposite to compressibility of air; that is, when subjected to pressure, such a gas would increase in volume instead of decrease.

Let us say that chamber *D*, Fig. 9, contains such a gas (shaded portion at bottom). Now when piston *P* makes a stroke, the action in chamber *D* is exactly the reverse of what takes place in chamber *C*. As the piston pressure builds up, water flows into chamber *C*, but flows out of chamber *D* because this gas expands under pressure. As the pressure decreases, water flows out of chamber *C* and flows into chamber *D*. Thus the actions of these two chambers tend to neutralize each other.

If the size of the chambers and the quantity of gas in each are equal and the quality of compressibility in gas *C* is balanced by the opposite quality of gas *D*, then the two chambers balance each other and the pump operates at its full capacity, or 100 per cent. power factor. The excess water in the two chambers *C* and *D* does not take up the capacity of the pump, as it merely flows back and forth between the chambers.

Comparing this to an electrical circuit, the action that takes place in *C* could be called inductance; that of *D*, capacity. Every induction motor causes an effect similar to *C*. The pump corresponds to the generator. The mechanical power that drives the piston corresponds to the prime mover. The water that flows back and forth between chamber *C* and chamber *D* corresponds to reactive current flowing back and forth between the rotors of induction motors and synchronous motors.

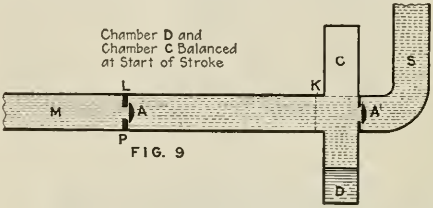


FIG. 9

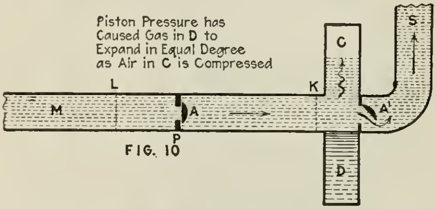


FIG. 10

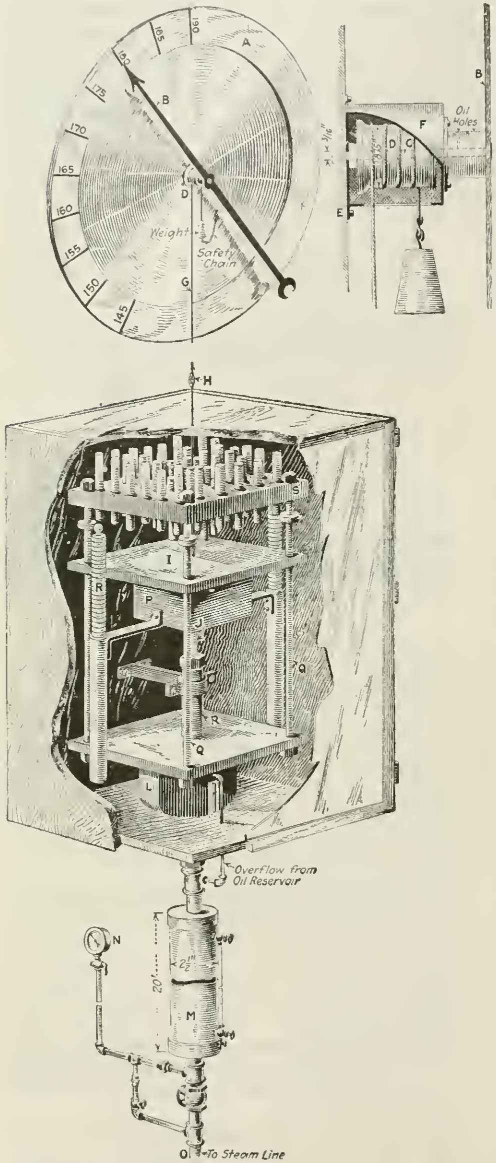
FIGS. 9 AND 10. CHAMBER D ADDED TO OVERCOME EFFECTS OF CHAMBER C, FIGS. 1 TO 8

When a pump (alternating-current generator) is operating at low power factor, the amount of water forced ahead of the piston at each forward stroke (volt-amperes) is just as large as if the power factor was 100 per cent. But the amount of water actually forced into the discharge pipe (watts to perform useful work) is less. And the power required to drive the piston back and forth (horsepower of prime mover) is not as much at low power factor because a part of the power used on the forward stroke is returned to the piston during the return stroke.

Now perhaps a mind picture is obtained of what happens when a synchronous motor (at leading power factor) is put on a circuit of lagging power factor. Useless current which has been loading up the generators is removed, and it is possible to get much more capacity out of the same generators, distribution system, etc. In fact, it is possible to get more work out of all apparatus on the system. The cost of producing and delivering electric power is also reduced.

Home-Made Master Steam Gage

An interesting auxiliary apparatus found in the Pratt Street Station of the United Electric and Railway Co., Baltimore, Md., is a home-made master steam gage



DETAILS OF THE MASTER STEAM GAGE CONSTRUCTION

that can be seen from all parts of the engine room. It was built by the chief engineer, Malcolm Wright.

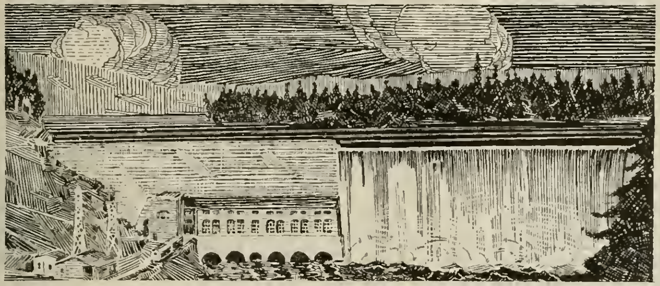
The dial of the gage *A* is made of wood and is 6 ft. in diameter with a rim 6 in. wide. As 180 lb. steam pressure is carried, the dial is numbered from 145 to 190 lb. An indicating pointer *B*, about 60 in. long, is secured to a shaft *C* which carries a flange spool *D* 0.875 in. in diameter at the winding section and ⅞ in. long. This roller shaft fits in a bearing in the rear support *E*, and the other end fits in a bearing that is secured to the casing *F*. A cord *G* makes three turns around the spool *D*, and at one end a weight 8 in. long and 1¼ in. in diameter is attached. To the bottom of the weight one end of a chain is fastened, and the other end is attached to the gage mounting. This chain is a safety precaution in case the cord should break. The other end of the cord *G* is attached to a turnbuckle *H*. This is made of a piece of ⅛-in. pipe threaded at both ends for screweye-rods. The lower end of the turnbuckle carries a cord that is secured to the crosshead *I* of a weighted piston *J* which moves up and down in a cylinder *K*, the movement corresponding to the pressure exerted on the bottom of the piston *J* by oil in the oil reservoir *L*, which is under boiler pressure. The reservoir *L* is piped to an oil reservoir *M* 2½ in. in diameter and 20 in. long. Both oil reservoirs are fitted with gage-glasses. At the bottom of the reservoir *M* suitable connections are made for the purpose of draining water and for attaching a gage *N* to be used as a check on the master gage. The pipe *O* is connected to the main steam header.

As stated, the indicating pointer on the gage is actuated by the movement of the weight plunger. The arrangement of the weights is the most important part of the apparatus. The main weight *P*, of lead, is carried directly by the plunger *J* and supports the crosshead *I*, which slides on the four uprights *Q*. On two sides of the weight *P* is bolted an angle iron that carries a number of adjusting weights *R*. With the weights *P* and *R* adjusted to balance a steam pressure of 162 lb., the dial pointer is also at the 162-lb. mark.

Across the top of the four guide posts *Q* is a perforated plate *S* in which 38 weights, each weighing 1 lb., are so placed that no two of them project below the plate *S* the same distance. These weights are hung on pins to give them the desired position. Thus, as the plunger is forced up by increased steam pressure, a 1-lb. weight is added to the plunger load for each pound increase in pressure, so that at a pressure of 180 lb. on the boiler the plunger will be carrying not only the weights *P* and *R*, but the thirty-eight 1-lb. weights as well. The gage pointer will then indicate 180 pounds.

As the pressure decreases the weights force the plunger *J* down until one of the 1-lb. weights rests on its pin which suspends it from the weight plate. If the steam pressure still decreases another pound, the weights will force the plunger *J* down still farther until another of the 1-lb. weights rests upon its supporting pin. Thus the variation in the boiler steam pressure lifts or seats one or more of the 1-lb. weights for pressures between 142 and 180 pounds.

One company alone, during 1918, built over 500 synchronous motors, aggregating 300,000 hp. capacity. This is exclusive of synchronous condensers. Of this number over 200 motors, with an aggregate capacity of 90,000 hp., were built for air-compressor drive alone. When it is considered that this represents the output of one company only, and that there are a half-dozen or more large companies building this type of machine, it will at once become apparent what an important factor the synchronous motor is becoming.



POP'S WATER-POWER COURSE

By

John S. Carpenter

"TO GET down to business," said Jimmy to Pop, "I'll bet you can't tell me the great differences between a Pelton wheel and a Francis turbine."

"Tryin' to heckle me, hey?"

"I call," said Jimmy. "What have you got?"

"Well, to begin at the beginnin', a Francis turbine always works 'drowned,' or in the water in some way or other, while a Pelton wheel always must work outa the water. It's true that the hull bloomin' thing will be wet, but it can't work efficiently when it's in the water."

"And next," interrupted Jimmy, for fear that Pop would get ahead of him, "they don't have any draft tubes."

"They uster make them with draft tubes," put in Pop, "but that means a float riggin' to keep the water at a certain level in the draft tube, so it will never git up to the wheel. Now with the heads the Pelton wheel is gen'ly used with, a few feet loss in head on account of havin' a free tailrace is of less consequence than all the time fussin' an' foolin' with a float riggin' that never was foolproof."

"And they don't take water all around the wheel like a turbine does."

"No, Jimmy; but it's quite common to see Pelton wheels with two or more streams a-playin' on them."

"And," continued Jimmy, "while a turbine may work with its shaft either horizontal or vertical, the Pelton wheel works best with its shaft horizontal."

"Yes, son," chimed in Pop, keeping right on Jimmy's heels, "they has them vertical on some whoppin' big jobs, but it's gen'ly admitted that what you say is so."

"And while the turbine is regarded as being most efficient at low heads, the Pelton wheel is most efficient at high heads, where a small jet or stream will do the work."

"Yes, that's true. The Francis turbine has been used up to 750 ft. head, but conservative practice puts the limit at about 500 ft.; the Pelton wheel, on the contrary, has been used on heads as low as 20 ft., but here agin, conservative practice says 50 ft. is low enough. But they's other considerations that sometimes makes the use of the Pelton wheel advisable under low and medium heads. Suppose a man wants a small amount of power under a medium head. In such a case the Pelton wheel would be the cheaper layout and much simpler, too. Now supposin' a feller has about 200 ft. head an' wants a fair-sized power at a moderate speed. The Francis turbine bein' essentially a high-speed machine, it would have to be made big so that they could git the speed down, or else drive through a lotta gearin', which is a bad proppysition an' to be avoided when you can. In such a case the Pelton wheel would have it on the turbine again.

"Now another frequent case. We'll say the water is bad, that it carries large quantities of silt or sand, or that it has acid in solution. In such a case the Francis turbine would not be thought of as competin' agin the Pelton wheel. The Francis turbine is quite a complicated machine agin the other, because it has so many machined joints that the water gits to. These joints, under bad conditions, would be so soon eaten out that the efficiency would be gone before you knowed it. Now with a Pelton wheel you'd take off the worn buckets and put on some new ones or take out the hull nozzle an' put in a new one in quick time. That's about the only parts that wear out on a Pelton wheel."

"But I thought you could take care of the sand by having the velocity in the forebay small enough so that it would settle, and that such things as branches and leaves can be taken out by a good trash rack?"

Sudden showers and freshets like they gits in tropical countries brings down sand an' leaves an' even young stones which would kill a turbine in a short time. Turbines ain't never been much of a success as stone crushers or pulp grinders. Another thing with the Pelton wheel, the discharge of the nozzle is free, so anything that can pass through the nozzle will be thrown on the buckets an' not hurt them."

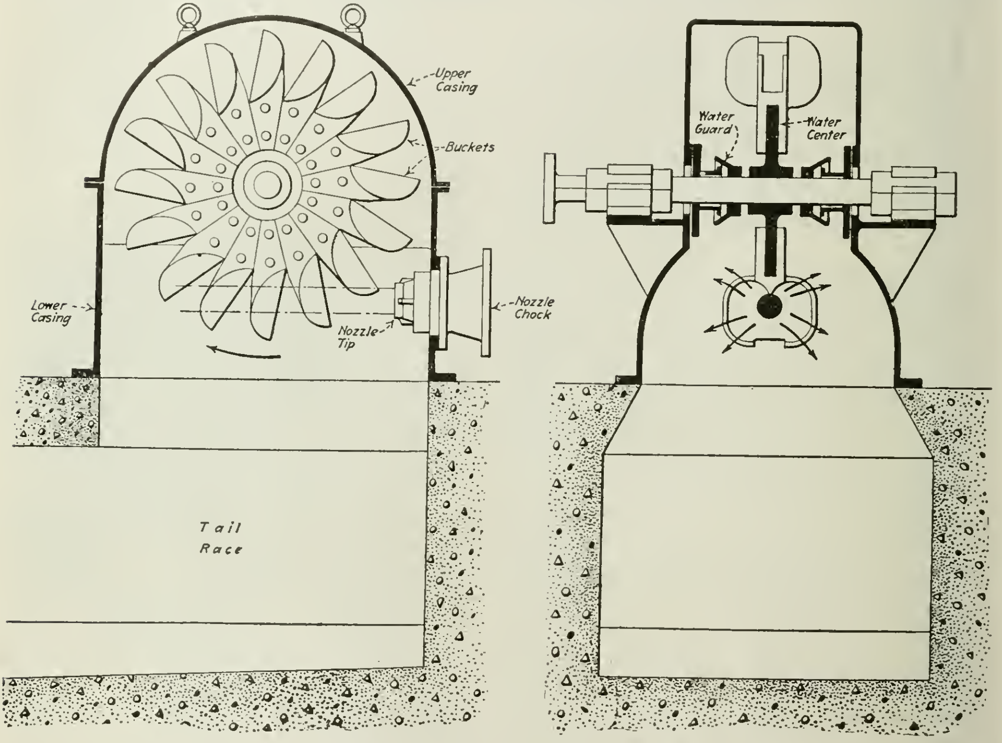
"You've told us quite a few advantages of the Pelton wheel; now tell us some of the disadvantages."

"Well, one of 'em is that the Pelton wheel has a very low specific speed as compared with the Francis turbine. Francis turbines have been made with a specific speed of 150, which of course is for very low heads, not exceeding 30 ft., while the best you can do with a Pelton wheel is about 7 with one jet on the wheel, or about 10 with one wheel and two jets. Of course, if you put two jets on two wheels, you can put them on one shaft and so git about 14, an' you can see it's darn low comparin' it to the turbine. That's about the worst you can say about the Pelton wheel.

"They's jes' one more little thing I wants to say. The Pelton wheel maintains its efficiency over a very wide range of load. It's possible to design a wheel that will have over 80 per cent. efficiency all the way from about quarter load to maximum capacity. Now it takes some turbine to do that, and you'll find that as a rule the turbine manufacturers don't holler very loud about the efficiency of their turbines from half-load down."

"Pop, tell us how the power is figured on Pelton wheels."

"How would you think it was done? The principles ain't any different than I showed you for the turbine. In the design it is common to assume the efficiency at 80 per cent. although the wheel will probably give more if well designed. Now, suppesin' you wants 500 hp. under, say, 400 ft. head. Long ago in these talks I gave you some power constants to use in figgerin' the water quantity. Now the constant for 80 per cent. efficiency is 11. So 500 times 11 is 5500, which, divided by the head, or 400, gives 13.75 cu.ft. per second. Again, I showed you how to figger the spoutin' velocity as 8 times the square root of the head. The square root of 400 is 20; so the velocity is 8 × 20 = 160 ft. per second. Divide 13.75 by 160 an' you gits 0.086 sq.ft. nozzle area. To this we adds 2 per cent. for nozzle losses, makin' 0.0877 sq.ft. Multiply that by 144 and you git 12.629, the area in square inches; an' fin'ly, from a table of areas of circles, you sees that 12.62 sq.in. corresponds to a shade more than 4 in. in diameter. See? Kinda easy, ain't it?"



PELTON TYPE OF WHEEL, ILLUSTRATING THE STREAM LINE OR PELTON CYCLE

"Now Pop, how about the speed? We haven't said what speed we're going to have."

"With the Pelton wheel, like the Francis turbine, there is a limit to the speed in r.p.m. that we can have. Now, by experience it has been found that the diameter on the stream line, or Pelton circle, as some engineers calls it (refer to the illustration), should not be less than about 9 times the diameter of the jet. They has made 'em with as low as 6½ diameters, but the efficiency ain't good and there is serious difficulties in gittin' enough buckets on the wheel. So in our case, we'll say the diameter is 36 in. on the stream line, an' we gotta be satisfied with the speed we git by so doin', or else divide the area of the nozzle between two streams so we then can make the diameter of the wheel 9 times the diameter of the smaller stream. In such a case the wheel could be made 25.5 in. in diameter with a correspondin' higher speed. But in this example we will stick to the idee of usin' one stream.

"Now, the Pelton wheel has another queer thing about it. It can't run at as wide a range of speed as the turbine. As I showed you before, the turbine can run at anything between 60 and 95 per cent. of the spoutin' velocity. But with the Pelton wheel we is tied down rather close, usually about 46 per cent. of the spoutin' velocity on the stream line. This, Jimmy, is the speed at which the wheel gives the best efficiency, an' the r.p.m. is figgered darn quick by multiplyin' 850 by the square root of the head an then dividin' by the diameter in inches on the stream line to git the r.p.m. or by the r.p.m. to git the diameter in inches. So, 850 times 20, the square root of 400, is 17,000; divide that by 36 in. an' we gits 472 r.p.m., which can be called 475."

"I suppose the bigger the wheel the more power you get, because you have more leverage with a big wheel than a small one. Is that right?"

"No, it ain't!" snapped Pop. "I seed a number of textbooks that says it is an' they oughta know better. When you makes the wheel big, you increase the leverage, but you decrease the speed as fast as you increase the leverage; so we can say the diameter of the wheel does not affect the power aside from secondary effects, as I says before about havin' the wheel so many times the jet diameter. Git me?"

"Yes, Pop, I get that. Now tell me if the number of buckets on the wheel affects its power."

"No, they don't affect the power as long as they is enough of them. They is supposed to catch every particle of pressure water outa the nozzle an' then turn it through an angle as near 180 deg. as possible."

"I heard the lecturer talking about 'ratio' to you while you had your right feet planted on Casey's footrail and your right elbows on his bar. Now, what does 'ratio' mean?"

"Ratio, as he used the word, means the ratio of the diameter on the stream line to the jet diameter."

"Oh, that's simple"

"Son, they is a relation between what we calls ratio and specific speed or type characteristic. Ratio times the specific speed is equal to a constant times the percentage of spoutin' velocity, the constant bein' 115.5. In other words, an' to take an example, we had a ratio of 9 in our previous example, an' 46 per cent. spoutin' velocity. Now multiply 115.5 by 0.46 an' we gits 53.1; divide 53.1 by 9 an' we gits the specific speed, 5.9. When the percentage of spoutin' velocity is 0.46, then you can divide 53.1 by the ratio to git the specific speed or divide the same number by the specific speed to git the ratio. I gives you a little table here:

Ratio........	6	7	8	9	10	11	12	14	16	18	20
Specific Speed	8.85	7.59	6.65	5.90	5.31	4.83	4.43	3.80	3.32	2.95	2.66

Git the idee?"

"Hot Patch" Furnace Cement

Constructing new boiler furnaces, replacing furnace linings and patching burned-out furnaces is expensive work, as each job requires cutting the boiler out of service. If a cement is used that will not disintegrate under furnace conditions as quickly as fireclay, the labor and the expense for setting upkeep can then be reduced.

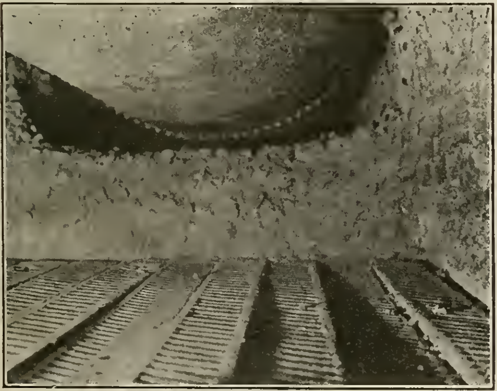


FIG. 1. FURNACE REPAIRED WITH "HOT PATCH" CEMENT

What is known as "Hot Patch" cement is made to give the furnace double life. It is a high-temperature resisting plastic compound that remains permanently adhesive at high temperatures. It is applied very thinly and upon drying becomes hard, adheres to the brick and forms a highly refractory wall. It is compounded so as to expand and contract closely with the brick. Thus there is practically equal expansion and contraction throughout the furnace brickwork.

Fig. 1 shows a furnace repaired with "Hot Patch" cement and Fig. 2 shows one repaired with fireclay: Both were under boilers in the same boiler house, and each had been in use and operating under the same conditions for ten months when the photographs were taken.

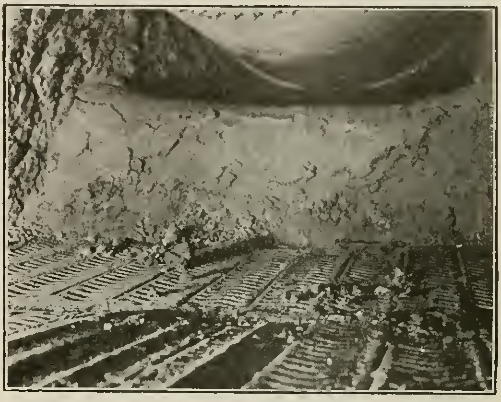


FIG. 2. FURNACE PREPAIRED WITH FIRECLAY

The cement is delivered by the S. Obermayer Co., Pittsburgh, Penn., in a dry state and is moistened when about to be used. The firebricks do not require moistening when using this cement. When applying it the bricks are laid with a close joint and the work is completed with a coat of cement applied with a stiff brush to the face of the brickwork. This forms a glaze and prevents air seepage through the bricks and also protects them from the furnace heat. About 350 lb. of cement is required per thousand 9-in. brick.

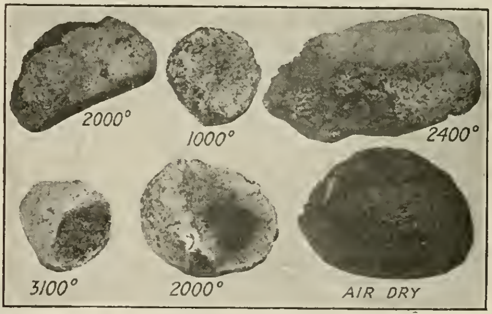


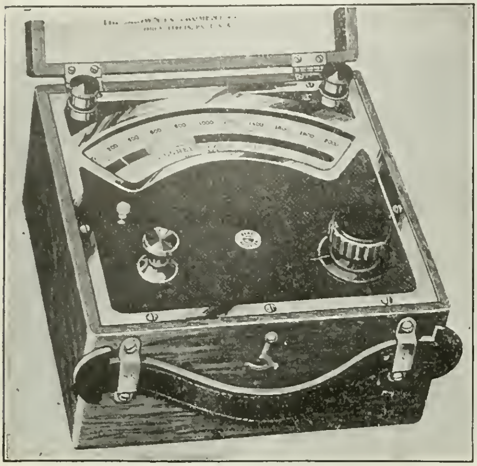
FIG. 3. "HOT PATCH" AS IT APPEARS UNDER DIFFERENT TEMPERATURES

Fig. 3 shows the appearance of the cement under different temperatures.

The Fuels Section of the Bureau of Mines is now engaged in an investigation of what actually happens in the combustion space of a powdered-coal-burning furnace, with particular reference to the ash disposal and furnace maintenance.

Brown Precision Heatmeter

Until comparatively recently, the determination of furnace and kiln temperatures by means of thermocouples was attended with complications and difficulties that made practical men, in some instances, doubtful in regard to the intrinsic value and reliability of the method.



PORTABLE PRECISION HEATMETER

Various devices and attachments have been made for use in connection with indicating and recording millivoltmeters and pyrometers, by means of which the instruments will remain direct-reading and at the same time be compensated for external or line resistance. Inventions of this class range all the way from a simple step rheostat connected in series with the "dead" resistor of the instrument, to the elaborate and complicated apparatus employing the substitution and deflection methods, the potential of the thermocouple being first balanced against another potential derived from a dry cell; and after an intermediate operation and an intercomparison of deflections, the effect of line resistance is finally balanced out by means of a rheostat, and direct deflections are obtained from the thermocouple current.

An instrument known as the Brown Precision Heatmeter, made by the Brown Instrument Co., Philadelphia, Penn., eliminates the effect of line and thermocouple resistance by means of a simple operation. In testing with this apparatus all that is necessary is to connect the thermocouple with the instrument binding posts in the usual manner, press a button, turn a knob and take a reading, which will be the correct electromotive force of the thermocouple at its hot end, even if the line is miles in length. In fact, the line may have as much as 15 ohms resistance.

This instrument is direct-reading throughout its entire scale range, requires no dry cells or standard cells, is independent of line or thermocouple resistance and has a negligible temperature coefficient.

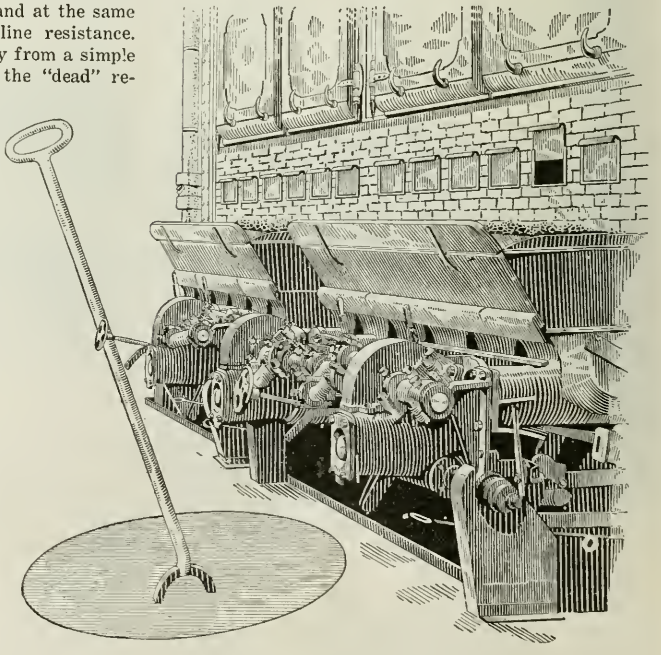
Cleaning Boiler Tubes of Outside Deposits

Engineers are familiar with the growth of ash deposit that accumulates on the first and second rows of tubes of water-tube boilers, especially where stokers are used and the boilers are run at capacity and over. The problem is to keep the outside of the tubes clean without cutting the boiler out of service while doing the work.

An interesting method of doing this work has been in use for some time at the Pratt Street Station of the United Electric and Railway Co., Baltimore, Md. In the front of each boiler setting, above the stoker coal hoppers of six water-tube boilers, six superheater clean-out doors have been built in the front brickwork, as shown in the illustration.

The boilers are 18 tubes wide, and each clean-out door permits of cleaning three tubes wide with a suitable tool, such as shown in the foreground. The scraper is made with a 4-in. radius to conform to the diameter of the boiler tube. It is fitted to a length of 1-in. pipe with a handle at the outer end. When cleaning tubes, one of the clean-out slides is lifted and the scraper end is pushed along the tubes, thus removing the accumulation of ash and clinker deposits.

The reason superheater clean-out doors were used was because they had been discarded from former boiler settings. They answered the purpose for cleaning tubes just as well as if special castings had been made for the job.



WATER-TUBE BOILER SETTINGS FITTED WITH CLEAN-OUT DOORS FOR SCRAPING TUBES

EDITORIALS

Publisher's Note

Owing to the unexpected prohibition of overtime by one of the printing trades in New York City this week, it has been necessary to cut down the number of pages in the present issue.

Coal-Saving Dopes

EVERY little while somebody appears with a compound which, dissolved in water and sprinkled upon coal, is alleged to produce a saving of from ten to fifty per cent.

Power has published analyses of many of these and has pointed out repeatedly that nothing that costs less than more coal is available to add to the heat value of the fuel. But still these compounds are invented and launched, and people buy them and use them and testify to savings effected by their use. You cannot argue against that kind of evidence, as Fra Hubbard said in his dispute with Ali Baba about the pebbles. Ali maintained that boulders were simply grown-up pebbles, and, when Hubbard expressed incredulity, said: "You see that rock over there. Well, I knew it when it wasn't more than so big."

What argument is there against that kind of a stand?

These people have tried the dope and burned less coal, and they know it. They would have burned less coal if they had used toilet water. There are few plants, especially house-heating plants, in which material savings cannot be made by convincing the operators that they are going to make a saving and getting them to watch their step. If sprinkling the coal pile with some of this dope dissolved in a watering can would produce a positive and sustained saving of even five per cent., it would be in universal use. Yet we do not know of one of these compounds that has been launched with so much hope and enthusiasm and promise that has enjoyed more than a brief and stimulated existence.

A prominent consulting engineer has recently put his name to a report testifying to a considerable saving by the use of a compound of this kind. The test was made upon a house-heating boiler, and a weighed quantity of treated coal would last longer than the same weight of the same coal untreated. He lays this effect to the fact—which, he says, repeated experiment established—that the treated coal burned more freely than the untreated. A draft that would keep the treated coal burning at a rate sufficient to keep up the desired temperature in the heating system would not keep the untreated coal alight, but with the greater draft required to keep it from going out, the untreated coal burned up more quickly than the treated with less draft.

When the reopening of the Rhode Island coal mines was attempted some years ago, a chemist by the name of Williams offered a substance which he claimed would make this hard graphitic coal burn more freely, and experiments with the substance stirred into a crucible with Rhode Island coal, or even pure graphite, seemed to show that there was such an effect. If this can be proved, it may be responsible for such savings as would be brought about by the use of a freer-burning coal with an apparatus not well adapted to the use of a hard coal.

The latest example of this sort of a compound is Coal-Life, which is being exploited in Vancouver. Its analysis shows 29 parts in 100 by weight of common salt, 24 of washing soda, about 22 of caustic soda and about 9 of lime. The rest is moisture and impurities—alumina, silica, and iron—the sum of the impurities being about one and one-half per cent.

Control in Power Plants

WITH respect to control of equipment in power plants considerable progress has been made since the days of not so long ago. Not only has automatic control supplanted hand control where practicable, but hand-manipulated control has in large measure given way to electrically and hydraulically actuated control.

The automatic feed-water regulator is not new, yet it is only within recent years that it has been recognized as not only a reliable but a valuable adjunct to a boiler. One of the great advantages of the automatic feed-water regulator is that it gives a lag between flow and load, which promotes a more uniform boiler pressure and conduces to less loss of heat immediately after a marked sudden decrease in load. The engineers of large plants are finding that in this respect they are far superior to the hand control of water tenders.

It made an inspiring picture—that where the brave man in overalls rushed through a cloud of steam to close a valve back of a hissing, roaring leak. Sometimes he never reached the valve; he was cooked in his tracks. That day is no more. It is gone the way of the obsolete. In the modern plant the engineer or responsible subordinate merely steps to the wall, presses a button—and presto, a motor on the valve spins it shut. Perhaps a break has occurred in a line or machine which, if unchecked, would cripple the station. Press the button and isolate the affected section; the remainder of the plant hums along undisturbed.

This latter system is one of the features of the new extension to the famous L Street Station of the Edison Electric Illuminating Company of Boston. In the course of a few weeks we expect to publish a description of this new station. Mr. Dean, the inventor of the system, will himself tell about the remote control of valves in this plant.

Here in this station combustion control is as nearly perfect as every essential means can make it. The boiler room doesn't look like a boiler room, as one visualizes such.

The United States spends over half a billion dollars annually on general education, but practically nothing toward the making of skilled mechanics. Our factories average little over fifty per cent. efficiency. Wherever established, industrial training became a revenue by reducing the labor turnover and making production cheaper in the training department than elsewhere in the factory.

• Correspondence •

Why the Atmospheric Line?

I beg to differ with W. L. Trill in his explanation of the atmospheric line (Sept. 9 issue of *Power*, Page 439).

Referring to M. J. Ile's diagrams (Aug. 12 issue of *Power*, Page 269), it will be noticed that the atmospheric line is not at the same height in all the diagrams, due no doubt to part of the pressure having got away either by condensation or leakage before he drew the atmospheric line.

If he was using a three-way cock, the handle in either extreme position would be open only to the engine cylinder. When the handle is in the *central* position, the indicator will be open to atmosphere through a small hole in the side of the three-way cock. Mr. Iles will probably find this passage gummed with oil, which would prevent the release of pressure in the indicator cylinder.

If he was using a straight-way cock, he may have turned the cock in the wrong position in closing, which would allow the steam pressure to blow through the vent, instead of relieving the indicator of pressure.

Claremont, N. H. I. F. RICHMOND.

I would like to state my ideas formed by experiences similar to Mr. Iles'. I have had this same thing occur several times with several engines, and I will mention as many different causes as I have so far found.

I do not believe the position of the atmospheric line is caused by a sticking piston, as the diagrams show that the piston dropped very smoothly when tracing the expansion and exhaust lines, and with a 70-lb. spring the chances of sticking would be remote.

My troubles of this kind were caused by a leaky three-way cock, in one case, which maintained a pressure on the piston of the indicator while tracing the atmospheric line. In another case the vent hole in the bottom of the three-way cock became clogged, which prevented the steam escaping from the indicator cylinder after the cock was thrown to mid-position, closing off both ports.

In another case, where only gate valves were used the same thing occurred when the valves became leaky, and I have also had it happen when using single straight cocks which leaked and with straight cocks that had no vent to the atmosphere when closed.

As I do not know just what kind of valves or cocks Mr. Iles has in service for controlling the steam between his engine cylinder and his indicator, it would be hard to tell just what causes his trouble, but any of the aforementioned conditions will do it.

Webster, Mass. L. M. REED.

I am of the opinion that the three-way cock leaks when in mid-position, allowing the pressure to accumulate to the extent shown. If a three-way cock is not used, then one or the other of the valves in the piping from the ends of the cylinder was leaking when the atmospheric line was drawn. Remove the indicator with card intact from the cylinder and draw the atmospheric line by pulling the cord by hand, and it will be in its proper position.

Sometimes a simple indicator cock is used. This cock has an atmospheric outlet in the shape of a small hole in one side. If the valve is turned so that the steam that has accumulated in the piping after the valves at the ends are closed can escape through the small hole, the atmospheric line will be drawn correctly.

Louisville, Ky. JOHN F. HURST.

In regard to Mr. Iles' indicator diagrams, with the limited information in regard to where the engine exhausts, I would say from the looks of the diagrams that his engine must exhaust into a closed heater where there is a partial vacuum formed, which causes the atmospheric line to show a vacuum. It looks as if the condition under which the engine exhausts is not the same at all times, as the atmospheric line is not the same in each diagram. C. A. SMITH.

Canton, N. C.

Saved $20,000 on Yearly Coal Bill

I came to my present position as chief engineer in October, 1917, and began needed alterations the next June after the heating season was over. I figured I would save at least 1000 tons of coal, but never dreamed of saving 2000 tons yearly. I believe most engineers would do as well as I did if they would leave their power houses in their spare time and trace their steam lines and return pipes and find out where the steam is going after leaving the power house and if used efficiently. Practically all changes were made away from the power house, and the greatest improvement, and what I believe saved us the most coal, was due to changing the steam traps on the radiators and installing new traps on the cooking utensils.

The plant consists of two 125-hp. and four 75-hp. return-tubular boilers; one steam engine, directly connected to a 110-volt d.c. generator and a rotary converter for purchased a.c. power at a voltage of 550, reconverting to 110 volts d.c. The power purchased averaged about 100 kw., and the service demanded 125 kw. during the day and about 60 kw. during the night. Heating service was required for 60,000 ft. of radiation, the returns of which were carried back to the power house by a vacuum pump. Forty thousand feet of this heating system was equipped with obsolete traps, and 20,000 ft. had no traps at all, using only two master traps. A 35-hp. ice machine operated at a voltage of 110 volts d.c. There were also 40 steam cooking appliances using steam at 75 lb. with no steam-trap equipment; the condensation flowed to a master receiver and pump and returned to the power house. A laundry, with a set of belt-driven, out-of-date machinery with four large stationary dry racks washed and ironed 15,000 pieces a week.

The 40,000 ft. of the heating system that was equipped with obsolete traps was reëquipped with modern traps, and the 20,000 ft. that had no traps, was equipped with modern traps. It was found in many cases that the parts of the old traps had been removed, and the steam was blowing through.

The steam-cooking apparatus was equipped with a valve for reducing the steam from 75 to 20 lb., and each piece of apparatus was given its own individual steam trap, doing away with the steam pump and receiver, the condensation being allowed to flow by gravity to the power house. In making this change we found several cases where, after the steam was allowed to flow through the steamers at 75 lb. pressure, the exhaust was allowed to escape to the atmosphere. A reducing valve was connected to these steamers, the pressure was reduced to 5 lb., and the exhaust was piped to the heating system. I figure that this change alone saved us a ton of coal a day.

A 550-volt a.c. motor was purchased for the ice machine, and the power was taken direct from the transformers instead of, as formerly, from the rotary converter. This allowed us to carry all the day load on the converter, and to shut down the steam engine, saving about three tons of coal daily for the summer. An economizer was purchased, and all the flue gases were utilized, thereby raising the temperature of the feed water for the boilers, making a saving of about 5 per cent. of the coal consumed.

The hot water that was used for domestic purposes was heated in heaters that had no trap or receiver equipment, and the condensation was allowed to flow to the drain, thus wasting thousands of pounds of water at a temperature of 145 deg. F. This was overcome by installing a pump and receiver for returning the condensation to the boilers.

A new set of modern direct-connected motor-driven laundry machinery was purchased, which we figure saves at least a ton of coal daily.

These changes cost $10,000 and save us 2000 tons of coal yearly, based on the consumption of 6000 tons yearly for the last three years. The coal cost us $10 per ton delivered to the bunkers. The investment was well worth the money spent on improvements as it will make a saving of $20,000 yearly. F. J. DOWLING.

Montreal, Canada.

The Fusing Temperature of Ash

In the article on page 332, Aug. 26 issue, by E. D. Hummel, entitled "Coal Analyses Made at the Power Plant," formula (2) shows that the percentage of volatile matter in the coal is the weight of residue divided by the weight of the sample and multiplied by 100. I presume the obvious fact that this should be loss of weight divided by weight of sample and multiplied by 100 has already been called to attention.

On page 354 L. J. Joffray, general fuel inspector of the Illinois Central R.R. discusses "Dirt in Coal." In Table II he gives analyses of ash and gives the fusing temperature of each of the various constituents of coal ash. He then draws the conclusions as to the effect of high sulphur and lime in causing low fusing points of the ash. Since his values for the fusing points of the various constituents are for the most part miles off, this alone would seem to discount his conclusions.

The Bureau of Standards and the United States Geophysical Laboratory give the following values for the fusing points of several constituents: silica oxide (SiO_2), 2957 deg. F.; aluminum oxide (Al_2O_3), 3722 deg. F.; calcium oxide (CaO), 4658 deg. F.; and magnesium oxide (MgO), 5072 deg. F. I have not been able to obtain their value on iron oxide (Fe_2O_3) and consequently cannot dispute his value on that.

I might say further that Mr. Joffray can draw only very general conclusions at best, even if his separate values were correct, as to the influence of the composition of the ash on the melting point, since he did not actually determine the ash-fusing point on each sample The Bureau of Mines has done a large amount of accurate work on the subject of ash fusion and has come to the conclusion that the melting is a complex process. It does not amount to the successive melting points of the various constituents of the ash, but of a series of solutions of one compound in another, and of the continual formation of new compounds of different fusing points. The bureau has been unable to correlate the fusing points with the percentage of each constituent present in a given sample of ash.

The samples of coal ash upon which the bureau drew its conclusions came, not only from all parts of the United States, but from England, China and Alaska and represented every class of fuel from anthracite down to peat; while Mr. Joffray drew his conclusions on ten samples of bituminous coal, all from one state.

While most of the points brought out in his article are good and are well worth serious consideration on the part of every large consumer of coal, it seems to me that he has jumped at conclusions on the fusing proposition with too little knowledge of the subject.

WILLIAM J. RISLEY, JR., Chemist
Decatur, Ill. McLaughlin Coal Reduction Co.

Water in Superheaters

In answer to F. L. Richards, in the July 29 issue of *Power*, I wish to state that most superheater manufacturers install a drain on their superheaters and advise draining off all water before firing up the boiler. This also applies when a boiler has been subjected to a hydrostatic test. While a superheater may be full of water when a boiler is fired up, it should, under normal working conditions, have all the water evaporated into steam before the boiler is cut in on the line. Probably no harm would be done the superheater in either case; however, it is not a water container but is designed for steam.

The only objection to water in superheaters when firing up is that it may be carried over in the steam line when the boiler cuts in on the line.

Sewickley, Penn. C. E. ALDRICH.

Engine Dashpot Oil

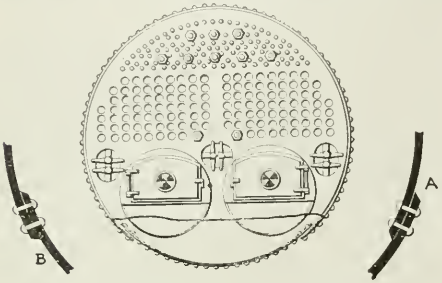
I have charge of a 16 x 18-in. automatic engine, speed 160 r.p.m. When I first took charge the dashpot was empty, so I used a mixture of half cylinder and half engine oil, which worked very well, but it was necessary to adjust the filling plug, which could be screwed down and cut off the bypass from one end of the dashpot to the other end. After a few trials the proper adjustment was found.

When the dashpot was disconnected, the eccentric would pound on the shaft, with the danger of breaking the eccentric casting. I tried cylinder oil alone, but it proved to be too stiff. MILLARD KURTZ.

Oakland, Calif.

Why Does One Seam Groove More Than Another?

The following is submitted in answer to A. Bennett's question on page 75 of the July 8 issue of *Power*, as to what may be the cause of grooving at the longitudinal seams of Lancashire or Cornish boilers. Mr. Bennett observed that whenever the bottom sheet of the boiler lapped over the outside of the shell, as at *A* (see illustration), no grooving took place, but with the bottom sheet placed inside of the shell, as at *B*, grooving was found in all stages.



JOINT *B* GROOVES. JOINT *A* DOES NOT

It is common knowledge that in Scotch-marine boilers there is a reduced circulation of water below the level of the grates in the furnace. The heat, being applied to the water from the top downward, virtually eliminates convection. There remains only the conduction of heat through the water, and as the feed water also enters into this cool zone, the lower 20 per cent. of the contents of the boiler remain comparatively cool.

While the boiler is in full operation, the bottom sheet will have a materially lower temperature than the rest of the shell. At 200 lb. gage pressure saturated steam has a temperature of 388 deg. F. and the feed water is probably 200 to 300 deg. lower. The bottom sheet will therefore tend to retain its original shape, while the upper part of the shell, under the influence of high pressure and heat, seeks to increase its diameter.

When the bottom sheet is riveted to the inside, as at *B*, the tendency is to open the seam, allowing water to enter, thus imposing a strain on the rivets. If, however, the bottom sheet is placed at the outside of the shell, as at *A*, the tendency is to close the seam tighter, allowing no water to enter the joint and putting but very little strain on the rivets. Moreover, at *B* there is an opportunity for sediment to concentrate and lie indefinitely upon the shelf formed by the top edge of the bottom sheet, thus favoring corrosion; at *A* there is no such opportunity.

This theory may be the explanation for the phenomenon reported by Mr. Bennett. At any rate it seems advisable to place the bottom sheet at the outside of the shell rather than at the inside.

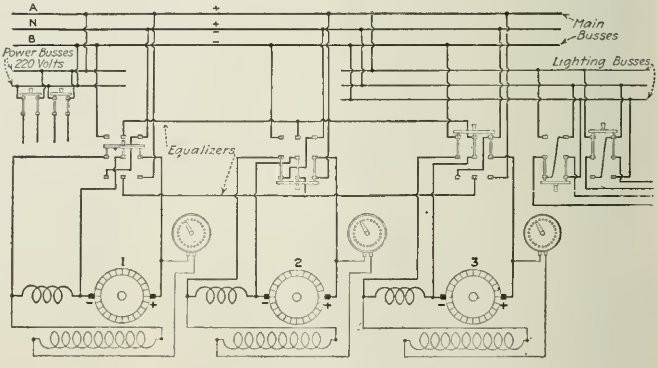
There are several methods for improving the circulation in Scotch-marine types of boilers. Some consist of inserting curved aprons or division sheets, etc., between the furnace flues and the boiler shell up to the tubes so as to guide and separate the warm ascending column of water from the cold descending column. This does away with cold dead water in the bottom of the boiler and should also counteract the grooving at the lap seams complained of. CHARLES H. HERTER.

New York City.

Series-Parallel Wiring for 110- or 220-Volt Service

A small power plant that had been used to supply light and power services at 110 and 220 volts had been changed over to supply 110 volts only. This plant was recently taken over by another firm, and it was decided to supply all services again from the one station instead of buying 220-volt power. The illustration shows the busses and also the main switches and connections. It will be seen that, with generators Nos. 2 and 3 connected as shown, generator No. 2 is supplying 110-volt power to busses *A* and *N*, and generator No. 3 is supplying 110-volt power to busses *N* and *B*. This connects the two generators in series across *A* and *B*, thus giving 220 volts across these two busses. The laminated type of bus is used, and where loads are likely to increase they will be found of great advantage, as copper bars can be added at any time.

Auxiliary power and lighting busses were put in to save loading up the main busses. All power switches installed are of the single-throw double-pole type, and the lighting switches are all double-throw double-pole. The lighting switches are connected to their three-wire busses, the switches being cross-connected as shown, so that the 110-volt load can be supplied from either side of the three-wire system. However, the polarity of the lighting circuits is not changed by throwing the switches.



SWITCHBOARD CONNECTIONS FOR SERIES OR PARALLEL OPERATION

There being no call for 220-volt service after 6 p.m., only one machine is run and all the light switches are thrown to two busses. It is proposed later on to put in the three-wire system to all the buildings supplied from this plant, but as the two-wire installation was in operation and the price of material is still high, this work is being held over. No trouble has been experienced since the change over was made.

Cambridge, Mass. J. A. CAMPBELL.

Inquiries of General Interest

Testing Cylinder Oil for Tarry Ingredients—How can a cylinder oil be tested for tarry residue? P. M.

Dissolve one part of the oil in about twenty parts of gasoline. Allow a sample to stand for an hour in a clean test-tube and the tar or other insoluble matter will collect on the bottom of the test-tube.

Dry-Kiln Couplings—What is the difference between dry-kiln and common pipe couplings? R. H.

In dry-kiln heating it is of importance that no leaks develop in the steam pipe or joints, or the contents of the kiln may be seriously damaged; and to insure against bad joints, pipe couplings of extra-heavy weight and length are used, and couplings of the kind are known as dry-kiln couplings.

Removing Burnt and Gummy Oil—What will clean burnt oil from the top of a steam chest and cylinder head of an engine? W. R. T.

Burnt and gummy oil can be removed with a strong lye water, made of about a pound of potash to a half bucket of water. Remove the cylinder head and lay it down with the face covered over for ten to fifteen hours with waste or cloths saturated with the lye water and apply the wash in the same manner to the top of the steam chest. This will soften the dirt so it can be readily scraped off the surfaces, which can then be cleaned up with sandpaper and brightened with oil and emery cloth.

Power Transmission for Difference in Belt Tension—What would be the difference in tension on the tight and the loose side of a belt traveling 1200 ft. per min. to transmit 6 hp.; and what number of horsepower would be transmitted with the same difference in tension for a belt speed of 400 ft. per min.? M. D.

Transmission of 6 hp., or 6 × 33,000 = 198,000 ft.-lb. per min., at a speed of 1200 ft. per min. would require a difference of tension of 198,000 ÷ 1200 = 165 lb., and a belt speed of 400 ft. per min. with the same difference of tension would transmit $\frac{400}{1200}$ of 6, or 2 horsepower.

Bending of Water Tubes—In erecting a water-tube boiler the weight of the front end was supported on planks inserted between the rows of tubes, and a few days after the boiler was put in use the tubes showed considerable buckling out of line. Would not this be attributable to the method of handling the boiler when erected? J. H. W.

It is not likely that supporting the boiler in the manner stated would occasion bending or buckling after use unless the deformation was perceptible before the boilers were fired. Bending of water tubes is often the result of overheating and sometimes occurs with most careful handling and use of a boiler. An explanation given is that in use one side of the tube becomes hotter and expands more than the other, resulting in a condition of an eccentrically loaded column, causing the tube to bend away from the longer side. With a tube once bent from inequal expansion, the deflection becomes more pronounced from use.

Appropriate Width for Double Belt—What width of open double leather belt would be suitable for transmitting 164 hp. from a 72-in. diameter driving pulley to a 26-in. diameter iron receiving pulley that is to make 650 r.p.m. with pulleys spaced 17 ft. 9 in. horizontal centers? R. P. H.

For reasonable service and durability it would be suitable to provide good-quality double leather belting on the basis of capacity for transmission of 1.8 as much as single belting, and rate the transmission appropriate per inch width of single belting as 1 hp. per 785 ft. travel per min., or 1 hp. per inch width of single belt on a 30-in. diameter pulley making 100 r.p.m. For the conditions stated this would require a double belt $\frac{164 \times 30 \times 100}{1.8 \times 26 \times 650}$ = about 16 in. wide.

Hammering of Geared Feed Pump—We are troubled with hammering of a geared triplex pump used for feeding hot water that is supplied from an open tank under a head of about three feet. Where should we look for the cause, and how can it be remedied? W. L.

It is probable that the pump is driven too fast for the pump chambers to become filled on account of length of suction pipe or small size of pipe and passages, which results in slippage of the pump on the suction strokes and hammering when the plungers come down on water that fills only a portion of the cylinders. If the pump is belt-driven and it is not otherwise convenient to try it out with slower speed, note whether the hammering stops when the speed is slowed down with the belt slipping from being thrown partly on the loose pulley.

Chimney Capacity for Greater Height and Smaller Flue—A stack having a flue 36 in. in diameter is 78 ft. high. How much will the capacity be increased if the height is increased to 100 ft. with the size of flue reduced to 34 in. in diameter at the top, and what will be the increase in force of draft? J. N. L.

For the same temperature of chimney gases the force or pressure of the draft at the base of the chimney will be directly as the height, or (100 − 78) × 100 ÷ 78 = about 28 per cent. greater, thereby permitting use of a lower grade of fuel. The discharge capacity is directly as the square root of the height and about proportional to the area, so that the boiler capacity with the proposed dimensions would be to the present capacity as $34 \times 34\sqrt{100}$ to $36 \times 36\sqrt{78}$, or only about 1 per cent. greater.

Horsepower of a Return-Tubular Boiler—What is the horsepower of a horizontal return-tubular boiler 6 ft. in diameter by 17 ft. long, containing 72 four-inch tubes? F. C.

In rating the horsepower size of a boiler from its dimensions, it is the general practice among builders and engineers to allow 10 sq.ft. of heating surface per horsepower, and to consider as heating surface all the surfaces that are surrounded by water of the boiler on one side and by flame or heated gases on the other, using the external instead of the internal diameter of tubes for greater convenience of calculation. For horizontal return-tubular boilers, it is customary to allow that the heating surface consists of two-thirds of the cylindrical shell, the sum of the internal areas of all tubes and two-thirds of the net area of the tube sheets. Reduced to inches, the dimensions of the boiler would be 72 in. in diameter by 204 in. long and the allowable heating surface would be:

Shell: $\frac{2}{3}$ of 72 × 3.1416 × 204 = 30,762 sq.in.
Tubes: 4 × 3.1416 × 204 × 72 = 184,575 sq.in.
Heads:
$\frac{2}{3}$ (72×72×0.7854) 2 − (4×4×0.7854) 72 = 4,524 sq.in.

Total........................ 219,861 sq.in.

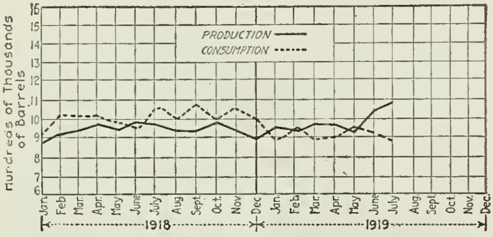
or 219,861 ÷ 144 = 1,526.8 sq.ft. of heating surface, making the size of the boiler 1,526.8 ÷ 10 = 152.68 hp.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. —Editor.]

Crude-Petroleum Situation in the United States

A comparative summary of the quantity of crude petroleum produced and marketed, imported, exported, and held in storage in the United States in July and June, 1919, and in July, 1918, has been prepared under the direction of the United States Geological Survey, Department of the Interior. The statements with regard to the fields east of the Rocky Mountains are based upon reports filed by about 200 pipe-line, marketing and refining companies, only such refineries being included as receive crude oil by private pipe lines or tank cars directly from the wells. Statistics relating to California and to imports and exports were compiled from secondary sources. This statement indicates the general trend of conditions in the crude-petroleum industry of this country.

The quantity of crude petroleum run from wells and producers' field-storage tanks and delivered to pipe lines, marketing companies, refineries and other consumers in the United States in July, 1919, amounted to approximately 33,521,000 bbl., an increase of 2,282,000 bbl., or 7.3 per cent., compared with June, 1919, the preceding record month, and of 3,160,000 bbl., or 10.4 per cent., compared with July, 1918. The average daily rate in July, 1919, was 1,081,323 bbl., a quantity greater by 40,023 bbl., or about 4 per cent., than the average daily rate in the preceding month, and by 101,936 bbl., or about 10 per cent., than the average daily rate in the corresponding month of last year. This notable increase, though in part seasonal, is ascribed largely to improved conditions in the market for drilling equipment, to continued high prices for oil and to the stimulation given to the quest for petroleum during the war.



ESTIMATED MONTHLY FLUCTUATIONS IN AVERAGE DAILY RATE OF CONSUMPTION AND PRODUCTION AND IN STOCKS OF DOMESTIC CRUDE PETROLEUM IN 1918-19, IN BARRELS OF 42 GALLONS

It is estimated that 98 per cent. of this oil was actually brought to the surface in the United States in the months specified, the remaining 2 per cent., consisting of runs or tank-car shipments from field storage. Data concerning the quantity of oil run into field storage are not available.

About 27,425,000 bbl. of domestic crude petroleum was delivered in July, 1919, to refineries and other consumers of crude oil and used for the manufacture of petroleum products and for fuel, or exported. This quantity is less by 333,000 bbl., or 1.2 per cent., than the quantity so delivered or consumed in June, 1919, and 5,826,000 bbl., or about 17.5 per cent., than the consumption in July, 1918. The average daily rate of consumption was 884,677 bbl., a decrease of 40,590, or about 4 per cent., compared with the daily rate in June, 1919, and of 187,936 bbl., or about 17.5 per cent., compared with the rate in June, 1918.

The notable increase during July, 1919, compared with the corresponding month of last year, shows the salutary effect of the termination of the war upon the surface reserve of domestic petroleum.

The United States leads the other countries of the world in the production of crude petroleum, but the quantity obtained from domestic sources is inadequate to meet the demand, and a large volume is imported, chiefly from Mexico.

Although the exports of the petroleum industry in the United States consist chiefly of refined products, a substantial volume of crude oil is being exported for the manufacture of petroleum products in Canada, Cuba and other foreign countries. The exports for July, 1919, totaled 205,642 bbl., for June of the same year 254,000 bbl., and in July 476,856 bbl., or more than was exported in both June and July of the previous year. The imports for July, 1919, were 4,487,652 bbl., for June, 1919, 4,728,141 bbl., and July, 1918, 2,832,786 barrels.

The following table was compiled from the records of the Bureau of Foreign and Domestic Commerce:

IMPORTS AND EXPORTS OF CRUDE PETROLEUM

(Barrels of 42 Gallons Each)

	July, 1919	June, 1919	July, 1918
Imports—Source:			
Mexico	4,462,910	4,703,212	2 817,702
Other countries	24 742	24,929	15,084
	4,487,652	4,728,141	2,832,786
Exports—Destination:			
Canada	188,261	254,209	454,838
Cuba			10
Mexico	774	79	280
Other countries	16,607	182	21,728
	205,642	254,470	476,856
Excess of imports over exports	4,282 010	4,473,671	2,355,930

Delay Faces the Water-Power Bill

In all probability the water-power bill must await the disposal of the peace treaty before it can be brought up for consideration on the floor of the Senate. Senator Jones of Washington, chairman of the Committee on Commerce, has made every effort to secure permission for the consideration of the bill during such times that the Peace Treaty was not actually before the Senate. This plan was defeated, however, by Senator Lenroot of Wisconsin, who opposes the bill. As it is conceded that Senator Lenroot probably could prevent any headway with the bill while the treaty was before the Senate, Senator Jones practically has agreed to await the disposal of the treaty before calling up the water-power bill. He advised the Senate, however, that immediately following the vote on the treaty, he would try to keep the bill constantly before the Senate until it is disposed of. He fully expects the measure to pass before the end of the extra session.

The bill as reported to the Senate contains several changes in the text of the bill passed by the House. It is believed, however, that the House will not object seriously to any of the amendments that were made by the Senate committee. The one substantial change is the prescribing of principles to govern the commission in the fixing of annual charges. The House bill gives the commission unlimited power to fix charges. The Senate committee objected to giving a blanket power to tax the licensees and resulted in the insertion of the following amendment:

> That the licensee shall pay for the license herein granted such reasonable annual charges as may be fixed by the commission, for the purpose of reimbursing the United States for the cost of administration of the act in relation to water powers developed under its jurisdiction, in the proportion that the water power developed by the project covered by said license bears to the total water power developed by all projects licensed under the act, and for that purpose such charges may be readjusted from time to time, not oftener than once in two years; the licensee shall also pay for the use and occupation of any public lands and lands in reservations except tribal lands embraced within Indian reservations necessary for the development of the project covered by the license such reasonable annual charges based upon the actual value of the Government lands used as may be fixed by the commission; but in no event shall the annual charge for the foregoing exceed 25 cents per developed horsepower: Provided, That when licenses are issued involving the use of Government dams or other structures owned by the United States or tribal lands embraced within Indian reservations the commission shall fix a reasonable annual charge for the use thereof, and such charges may be readjusted at the end of twenty years after the beginning of operations and at periods of not less than ten years thereafter in a manner to be described in each license.

A change was made in section 15 of the bill providing that in case the United States does not exercise the right to take over the works the license tendered shall be "on reasonable terms" and "which is accepted" by the original or the new licensee. That provision was thought necessary to make it certain that capital would invest under the law. The Senate committee changed the salary of the secretary of the commission from $5000 to $6000 a year and made various changes and additions to the language looking to clarification. In reporting the bill to the Senate, Senator Jones said:

> It is unnecessary to point out the need for or the beneficent results to come from water-power development. It means a saving of coal and a lower price for that used; a saving of oil and a lower price for that consumed; more efficient transportation and lower cost of service; the development of new industries; the building up of new communities; the creation of new property values, subject to taxation for the support and maintenance of local and state governments; and added employment for labor and increased markets for agricultural products. Every year that our water power is undeveloped means a loss to the people in one form or another, almost, if not quite, equal to the cost of their development. Legislative action should be delayed no longer. We should do one of two things: We should pass legislation that will lead private capital and enterprise to develop these resources under such regulations as will give consumers good service and cheap power or the Government itself should proceed to make this development. This bill proceeds on the theory of private development with ultimate public ownership possible. While some of the fundamental provisions of this measure do not meet the approval of the members of the committee, we deem it wise to accept them in view of the legislative situation, rather than incur the result of no legislation on this important subject.

Government Investigates Salt Lake City Smoke

Salt Lake City has arranged for a thorough investigation of its smoke condition, which, in the winter time, has become so serious as to menace the health and comfort of the community. Owing to its location, surrounded as it is with a fringe of high mountains, the air currents for the greater part of the year are insufficient to carry away the smoke and gases and they hang like a pall over the city and constitute one of the greatest problems to be met in its municipal affairs.

The work will be done by the United States Bureau of Mines, in coöperation with the University of Utah, and will continue throughout the coming heating season, the Bureau operating under the provisions of the Sundry Appropriations Bill giving it authority to extend aid to cities interested in smoke abatement.

Osborn Monnett, consulting engineer, of Chicago, has been retained by the bureau to direct the work. Preliminary investigation having to do with the constant smokers started on Sept. 1, and the gathering of data will go on as the heating season progresses. The scope of the work will include not only smoke, but smelter gases, as well as all other forms of atmospheric pollution. A scientific study of the subject will be made, and complete recommendations for eliminating the smoke will be submitted after the investigation is finished.

In the preliminary investigation now under way, Ringelmann chart readings are being made of the smoke density from plants that have been constant offenders. In addition the amounts of coal being consumed by these plants are being obtained to give some idea of the amount of smoke made relative to the total smoke of the city. A fuel survey is also under way.

As the heating season advances, complete Ringelmann chart readings will be made on the residences, the smoke made by the different classes of domestic apparatus being determined to ascertain the seriousness of this class of offender as related to the entire problem. The large heating plants, such as apartment houses, hotels, etc., will receive attention as soon as they begin to smoke.

A soot-fall study is under way, deposits being collected in jars placed at 20 different points throughout the city. These jars will be collected periodically and the proportionate amount of deposit ascertained from month to month as the season progresses.

Preparation is being made also for a careful and scientific examination of the atmosphere throughout the season to determine the influence of smoke and of smelter gases. Laboratory apparatus is being used for taking and filtering air samples, the filtrate to be examined chemically and microscopically. The character of the atmospheric content will be determined for the different localities, such as residence, business, industrial, etc.

In studying the peculiar surroundings and local conditions of the city advantage will be taken of the assistance of the local weather bureau. Maps and charts, elevations and profiles will be gathered, together with wind velocities, humidity and other meteorological data having a bearing on the case.

It is proposed also to have a corps of demonstrators who will give personal instruction in the operation of domestic heating apparatus, with the idea of reducing smoke to the minimum. By students from the university, a canvass will be made of the types of equipment in use in the city and a special study of this equipment looking toward smokeless operation will be made. There are a number of furnaces, boilers, stoves, etc., now on the market that are supposed to operate smokelessly with soft coal. Tests of such apparatus using the local coals of the territory will be made to determine just how far they will go to eliminate the smoke nuisance.

With smoke reduction still in view experts will be sent to investigate the local deposits of anthracite in the State of Utah, and it is also proposed to investigate the low-temperature coking properties of the coals available in the city. Although low-temperature distillation has not been fully developed, it promises to be a great factor in solving the smoke problem of residence localities. In making low-temperature coke, a considerable amount of volatile matter is left in the fuel, which gives it a property akin to semibituminous coal, producing a fuel that is easily ignited and can be used by the average householder without special instruction. The value of byproducts from this process will receive attention, and the feasibility of the entire process will be considered as one of the possible solutions of the smoke problem.

The American Boiler Manufacturers Association

At its annual meeting at Buffalo in June the American Boiler Manufacturers Association voted to hold quarterly meetings. The first of these was held at the Hotel Astor, New York, on Wednesday, Sept. 24. The forenoon was devoted to discussing costs. The results of estimates on the cost of a horizontal-tubular boiler of standard design as computed by 22 different builders averaged $3819, and the estimates varied from 28 per cent. above to 14 per cent. below this price. Estimates upon some of the details varied widely and the discussion promised to be useful in unifying methods of figuring, the handling of overhead, etc. The afternoon was devoted to routine business.

The public hearing on proposed municipal regulations for storage and use of fuel oil in New York City, held Sept. 24 before the Board of Standards and Appeals, will be continued on Wednesday, Oct. 1, 10 a.m., in the rooms of the board, ninth floor of the Municipal Building. The session held on the 24th inst. covered consideration of permissible flash point and specific gravity for fuel oil; manner of storage; location of tanks in existing and new buildings; enclosure of tanks; capacity of tanks located within and without the fire limits, and materials of tank construction. Additional recommendations and suggestions under these heads will be received by the board Oct. 1, and consideration will be made of the subjects: Vent and fill pipes; feed systems; pumps and piping; controlling valves; heating to reduce viscocity; burners; auxiliary supply tanks; fire extinguishing equipment; operation of plant, and official approval of installations.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F. o. b. mines, net tons	$2.40@2.90	$2.85@3.25
F. o. b. Philadelphia, gross tons	4.50@5.10	5.05@5.50
F. o. b. New York, gross tons	4.85@5.45	5.40@5.80
Alongside Boston (water coal), gross tons	6.75@7.60	7.50@7.75

Georges Creek is quoted at $3.70 per net ton, f. o. b. mines.

Pocahontas and New River quotations continue on the basis of 6.@6.50 per gross ton f. o. b. Norfolk and Newport News, but no sales are reported at these figures other than for export or bunker trade.

NEW YORK—Current quotations, White Ash, per gross tons, f o.b. Tidewater, at the lower ports* are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5.95	$7.80	Pea	$5.30	$7.05
Egg	6.35	8.20	Buckwheat	3.40	5.15
Stove	6.60	8.45	Rice	2.75	4.50
Chestnut	6.70	8.55	Barley	2.25	4.00

Bituminous

Current quotations on spot coal, net tons, at the mines average about as follows:

	Spot
South Fork (best)	$3.25@3.50
Cambria (best)	3.00@3.25
Cambria (ordinary)	2.70@2.90
Clearfield (best)	3.00@3.25
Clearfield (ordinary)	2.70@2.90
Reynoldsville	2.85@2.90
Quemahoning	3.25@3.50
Somerset (medium)	3.00@3.25
Somerset (poor)	2.65@2.75
Western Maryland	2.65@2.75
Fairmont	2.50@2.65
Fairmont ¾ in.	3.10@3.25
Latrobe	2.75@2.90
Greensburg	2.75@3.00
Westmoreland ¾ in.	3.50@3.75
Westmoreland run-of-mine	3.20@3.35

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide	Anthracite	Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	6.35	8.20	Rice	2.75	3.65
Stove	6.60	8.45	Boiler	2.50	3.50
Nut	6.20	8.55	Barley	2.25	3.15
Pea	5.30	6.90			

PITTSBURGH—Counting out occasional low and high priced sales involving but small tonnage, the great bulk of the transactions is quotable as follows, Pittsburgh District:

	Per Net Ton
Steam:	
Slack	$2.10@2.30
Mine-run	2.50@2.60
Gas:	
Slack	2.20@2.40
Mine-run	2.50@2.70
Prepared sizes	2.60@2.80

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.30@2.60	$2.30@2.60	$2.40
Black Creek and Cahaba	3.45@3.86	3.45@3.85	3.05
Jagger - Pratt Corona	2.85	3.00	2.45
Blacksmith	....	5.25	.....

Domestic quotations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	5.00@$5.50
Corona	3.50
Jagger	3.50
Montvallo	5.50@$6.00

Quotations on recent representative sales are as follows:

	Franklin County	Williamson County	Springfield	Norther Illinois
Prepared sizes	3.25	3.20	3.00	3.75
Mine-Run	2.70	2.50	2.30	2.30
Screenings	2.50	2.10	2.00	2.35

New Construction

PROPOSED WORK

N. H., Portsmouth—Spec. No. 4017, the Bureau of Yards & Docks, Navy Department, Washington, D. C., received bids for installing 1000 kw. turbo generator, at the Navy Yard here, from Rideout Chandler & Joyce, 178 High St., Boston, $9,066; Shevlin Engineering Co., 110 West 34th St., New York City, $10,540; Raymond R. Bill & Co., 55 Fort St., Springfield, Mass., $11,868. Noted Sept. 9.

Mass., Holyoke—H. L. Gendreau, Engr., 755 Gratton St., Willimansett, will soon receive bids for the construction of a 3 story garage on Race and Appleton St. A steam heating system will be installed in same. Total estimated cost, $125,000. Owner's name withheld.

N. Y., New York (Stapleton)—J. A. Wetmore, Supervising Architect, Treasury Department, Washington, D. C., received bids for the construction of a temporary boiler plant at the Marine Hospital here, from Almiral & Co., 1 Dominick St., $3245; John R. Proctor, 74 Courtland St., New York City, $3775; Austin Heating Corporation, New York City, $3965.

Pa., Philadelphia—G. C. Nimmons & Co., 120 South Michigan Ave., Chicago is receiving bids for the construction of a mail order plant, here, for Sears Roebuck & Co., Arthington and Homan Ave., Chicago, to consist of 3 buildings, one 9 story, 300 x 442 ft., one 6 story, 80 x 420 ft., and a power house. Total estimated cost, $4,500,000.

Pa., Pittsburgh—John Swan, Director of Department of Public Works, will soon award the contract for furnishing and delivering mechanical draft equipment including fan, engine, etc., at the Herron Hill Pumping Station. N. S. Sprague, City Co. Bldg., Engr.

Md., Annapolis—Spec., No. 4025, The Bureau of Yards & Docks, Navy Department, Washington, D. C., (late bid), received bids for installing 3 boilers in the naval academy here, from E. Keeler & Co., 238 West St., Williamsport, Pa., $37,249; H. E. Crook Co., 28 Light St., Baltimore, $40,325; Heine Safety Boiler Co., 1120 Pennsylvania Bldg., Philadelphia, $41,290; Babcock & Wilcox Co., 11 North American Bldg., Phila., $54,338. Noted Sept. 2.

Md., Annapolis—Spec. No. 4025, The Bureau of Yards & Docks, Navy Department, Washington, D. C., will soon award the contract for the construction of a power and boiler plant at the Naval Academy here. Total estimated cost, $45,000.

Md., Annapolis—Spec. No. 4026, The Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids for the construction of an ash bunker and addition to power house. Estimated cost, $96,000.

S. C., Charleston—Spec., No. 4011, The Bureau of Yards & Docks, Navy Department, Washington, D. C., received bids for installing 2500 kva. turbo-alternator at the Navy Yard here, from the Shevlin Engineering Co., 110 West 34th St., New York City, $25,680; Carroll Electric Co., 714 12th St., N. W., Washington, D. C., $27,335; Almiral & Co., No. 1 Dominic St., New York City, $37,526. Noted Sept. 9.

Ala., Birmingham—The Preston Motors Corporation plans to construct a 60 x 80 ft. power house in connection with proposed plant. R. A. Skinner, Pres. and Ch. Engr.

Ohio, Cleveland—The Martin Barris Co., 2048 West 3rd St., is having plans prepared for the construction of a 2 story, 36 x 165 ft. saw mill and power house. A steam heating system will be installed in same. Total estimated cost, $100,000. G. S. Rider, Century Bldg., Engr.

Ohio, Cleveland—The Vita Manufacturing Co., Williamson Bldg., is receiving bids for the construction of a 1 story, 132 x 252 ft. factory, on Madison Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Youngstown—The Board of Education, 20 West Wood St., will receive bids until October 6, for furnishing all material and installing a complete Miles Cabinet heating and ventilating system in the proposed U. S. Grant School, on the corner of Ridge Ave. and Edwards St. S. R. Creps, Dir. of Schools.

Mich., Detroit—The Board of Education, 50 Broadway Ave., received bids for the installation of heating, ventilating and plumbing systems in (a) Angell School, (b) Carstens School addition, (c) Trowbridge School addition, (d) open air school on Clippert site, (e) open air school, Davison Annex, from J. W. Partlan, Park Place, (a) $43,890, (c) $36,833; Irvine & Meier, 2289 Woodward Ave., (a) $48,599, (b) $52,051, (d) $6,512, (e) $7393; Drake Avery Co., 40 State St., (a) $49,217, (c) $40,715; W. J. Renolt, 506 Owen Bldg., (b) $51,051, (c) $40,325, (d) $18,397, (e) $8603; R. L. Spitzley Heating Co., Vinton Bldg., (b) $58,177; A. W. Schultz & Co., 815 Gratiot Ave., (d) $12,788, (e) $12,289.

Mich., Detroit—The Board of Water Commissioners, 232 Jefferson Ave., will soon award the contract for the construction of foundation and sub-structure for lift pumping station, placing of 1600 lin.ft. of electric conduit. Total estimated cost, $300,000. T. Aleisen, Engr.

Mich., Detroit—The Commissioner of Purchases & Supplies, Municipal Bldg., will soon award the contract for furnishing 16 single phase, oil insulated self cooling high efficiency type transformers for out door service, 60 cycle; 2 transformers 3300 volts primary 110-220 secondary, Scott connected to transform 3300 volts 3 phase to 110 and 220 volts, 2 phase; 14 transformers 2300-volt primary 115-230 volts secondary; two 75 kva., three 50 kva., two 40 kva., four 30 kva., four 30 kva. and three 5 kva.

Mich., St. Louis—H. B. Gullding, City Clerk, will soon receive bids for furnishing one generator set, 280 kw., 2300 volt, 3 phase, 60 cycle generator, coupled through reduction gears to condensing type steam turbine.

Wis., Sheboygan—The Vollroth Co., West Michigan Ave., plans to build an electric power plant and rebuild its heating system. Estimated cost, $50,000. Cahill-Douglas Co., 128 Grand Ave., Milwaukee, Engr.

Minn., Fairmont—The City Clerk will receive bids until October 7 for the construction of a 1 story, 83 x 83 ft. electrical power house. Total estimated cost, $175,000. A. Horone, Engr.

Minn., Minneapolis—The Minneapolis Sanitary Ice Co., 535 Metropolitan Bank Bldg., is receiving bids for the construction of a 1 story, 160 x 210 ft. ice factory on 29th St. Estimated cost, $75,000.

Wash., Fairview—(Seattle P. O.) A. Kristoferson Co., Eastlake Ave., plans to build a 2 story, 100 x 100 ft. milk plant, to include refrigerating plant, mechanical carriers, elevators, power plant and compressed air plant. Total estimated cost without equipment, $50,000. E. Sto[illegible], New York Block, Seattle, Arch.

Wash., Seattle—The City Council will receive bids until October 8 for furnishing and installing condensers, pumps, 6 new boilers and a 10,000 kw. generator, for increasing Lake Union steam plant. Total estimated cost, $1,250,000. D. Huntington, City Arch.

Ore., Stanfield—J. M. Kyle, Mayor, will receive bids until October 2 for furnishing labor and materials for the construction of a waterworks system and for the installation of a pumping system. Total estimated cost, $10,000. C. R. Hazen, City Clk.

Ont., Oshawa—B. H. Prack, Engr., Lumsden Bldg., Toronto, will receive bids until October 3, for the construction of a sheet metal products factory, consisting of 5 structural steel buildings for the Pedlar People, Ltd. Plans include a central heating and power plant, (direct and indirect systems will be used). Total estimated cost, $500,000.

Mex., Vera Cruz—Magrassi & Arzoni, Gutierrez Zamora, are in the market for a second hand substantial, 30 x 40 hp. crude oil or kerosene engine, in good condition.

CONTRACTS AWARDED

Mass., Worcester—The city has awarded the contract for the construction of a 2 story, 33 x 190 ft. hospital on Belmont St., to J. J. Roberts, 4 Wall St. A steam heating system will be installed in same. Total estimated cost, $100,000.

N. Y., Long Island City—The Gehnrich Indirect Heat Oven Co., 60 Franklin Ave., Brooklyn, has awarded the contract for the construction of a 2 story factory on Skillman Ave., to L. Gold, 44 Court St., Brooklyn. A steam heating system will be installed in same. Total estimated cost, $300,000.

N. J., Newark—W. A. Swasey, Arch., 101 Park Ave., New York City, has awarded the contract for the construction of a 150 x 150 ft. theater on Broad and Rector St. to Norton, Bird & Whitman, 601 5th Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $500,000. Owner's name withheld.

POWER

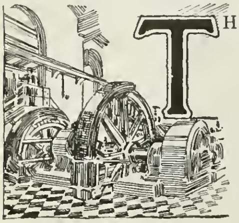
Volume 50 New York October 7, 1919 *Number* 15

What We Are Really All Working For

Efficient Operation of Central Power Stations

BY J. D. MORGAN

The efficient operation of central-power stations involves knowledge of accurate records, both daily and monthly, of the operation of every unit and of the station as a whole, systematic testing of all units to detect any falling off in efficiency and the exact cost data and the distribution of the total cost in the various departments of the plant. This article presents data and curves of importance to power-plant operators.



THE FIRST record necessary to the operation of any power plant is that of a load-curve sheet. This sheet should also have on it the capacity of the turbines or engines in service and available, number of boilers on the line and number available for service. It should be spotted as often as the load condition materially changes; in most cases every 15 min. will be found to be about right.

Then there should be a boiler-room sheet, to show the number of boilers on the line, banked and out of service each hour, when and what boilers were cleaned and blown down, temperature of the boiler-feed water, readings of feed-water meters, house-service meters, etc., for each watch, number of feed-water pumps on the line and the temperature of the discharge from each pump.

An engine-room sheet is also needed and should have the following data: Time, load, vacuum, barometer, circulating-water temperature in and out, hotwell temperature, steam pressure, temperature of steam, degrees of superheat, stage pressure, temperature of oil on bearings, temperature of oil to cooler and out. All these readings should be taken at least once every hour on every main unit.

If the plant uses salt water for circulating water, a condenser salt-test sheet should be kept. This record should show the degree of salt in the condensate from each condenser once every hour.

An electrical sheet should have on it the following data for every unit: load in kilowatts, power factor, amperes per phase, voltage, field amperes, frequency and armature temperature. No doubt the electrical sheet will need other data, but it is impossible to mention them here, for the class of service rendered will govern these items.

The daily station log sheet should be a summary of all the records taken during the day. A sample sheet of this record is shown in Fig. 1. This sheet was adopted by a large electric company in the New York district, and it enables the home office to keep in touch with the daily operation of each station in its district of operation.

The monthly generating report sheet (Fig. 2) should be a very comprehensive one of the operation of the station for the month. A comparison should be made with the operation of the station a year ago. This will enable the engineer in charge to see at a glance how each operating point compares with last year.

A monthly condenser-performance record should have on it the average daily readings of the following items: Date, load, vacuum (30-in. barometer), temperature of vacuum, temperature of hotwell, temperature of inlet water, temperature of outlet water, temperature rise, difference between temperature of vacuum and outlet water, pounds of steam condensed per hour, gallons of circulating water per minute (this item can be calculated from the temperature rise and the pounds of steam condensed per hour).

An example of what the monthly steam report sheet should contain is as follows:

STEAM REPORT FOR DECEMBER, 1914 (80,000 KW. STATION, PLANT FACTOR, 44 PER CENT.)

	Per Cent.
Steam used by main units	83.7392
Steam used by auxiliary units	13.6912
Steam used by cable testing	0.0520
Steam lost due to radiation	0.1692
Steam used for heating station	0.3744
Steam used for cleaning wiping towels, waste, etc	0.0166
Steam sold to contractors	0.0012
Steam used for fan and stoker engines on boilers	1.9608

All charts from curve-drawing instruments should be averaged and placed on racks where they can be easily reached, for these charts will furnish the engineer with valuable data on the daily operation of his station.

The daily average of all readings taken in the station should be kept in a card index. The record of repairs made to each individual machine, also the name-plate data of each machine, should be kept on these cards. This record will be found invaluable when it becomes necessary to look up back data or to order repair parts for the various machines.

The value of the yearly curves cannot be estimated, for they show clearly the daily operation of the station for the year. Fig. 3 shows the curves for condenser performance and Figs. 4, 5 and 6 show yearly curves.

Every engineer will find, once he starts to try to obtain records that will accurately show the operation of his station, that he will from time to time need various other records than those mentioned herein.

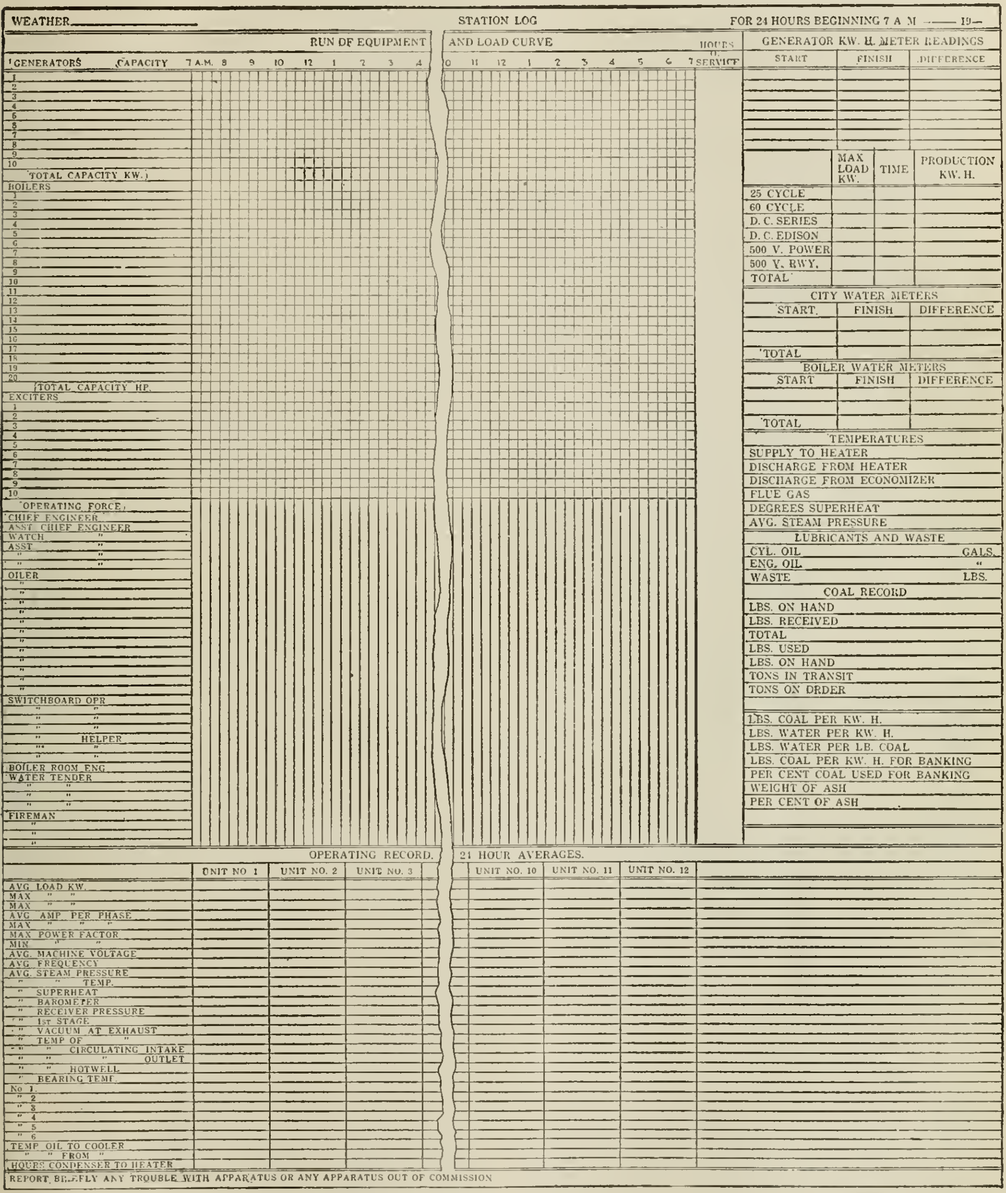
STARTING A SYSTEMATIC TEST METHOD

As soon as a complete set of records has been started the next point that confronts an engineer is that of starting a systematic test method. Testing in a power station has in the past been left to the laboratory department of the company, and this has resulted in the accumulation of a mass of data largely theoretical, and these data have been of little value to the operating engineer as an aid to the efficient operation of his station.

Power-plant testing should be under the direction of men who, first of all, understand practical operation and, secondly, are well versed in the theoretical side of engineering. A man of such qualifications must be developed from men who, first of all, have had a thorough engineering education and who are willing to learn power-station operation by getting in and doing the actual work.

The first test to be made in any power plant is that of the station water-rate test. If the plant is a small one, all the feed water fed to the boilers or feed-water heaters can be weighed, or in a large plant the water fed to the feed-water heaters can be calculated from a hook gage and a V-notch meter. The latter method is very reliable and is the one that is most generally used.

The output in kilowatt-hours should be read every hour, the temperature of boiler-feed water, temperature of steam, steam pressure, temperature of water feed and feed-water heater, temperature and pressure of the exhaust-steam fed to the feed-water heater, temperature of gases to and from the economizer, temperature of feed water to and from economizer, should be taken at least once every six minutes. The height of water in the boilers and feed-water heaters should be obtained once



WEATHER________ STATION LOG FOR 24 HOURS BEGINNING 7 A M —— 19—

RUN OF EQUIPMENT AND LOAD CURVE

GENERATORS CAPACITY 7 A.M. 8 9 10 12 1 2 3 4 0 11 12 1 2 3 4 5 6 7 HOURS OF SERVICE

1
2
3
4
6
5
7
8
9
10
TOTAL CAPACITY KW.
BOILERS
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
TOTAL CAPACITY HP.
EXCITERS
1
2
3
4
5
6
7
8
9
10
OPERATING FORCE
CHIEF ENGINEER
ASST CHIEF ENGINEER
WATCH "
ASST "
" "
" "
OILER
"
"
"
"
"
"
"
"
"
"
"
"
SWITCHBOARD OPR
" "
" "
" "
" HELPER
" "
" "
BOILER ROOM ENG
WATER TENDER
" "
" "
" "
FIREMAN
"
"
"

GENERATOR KW. H. METER READINGS		
START	FINISH	DIFFERENCE

	MAX LOAD KW.	TIME	PRODUCTION KW. H.
25 CYCLE			
60 CYCLE			
D. C. SERIES			
D. C. EDISON			
500 V. POWER			
500 V. RWY.			
TOTAL			

CITY WATER METERS

START.	FINISH	DIFFERENCE
TOTAL		

BOILER WATER METERS

START	FINISH	DIFFERENCE
TOTAL		

TEMPERATURES
SUPPLY TO HEATER
DISCHARGE FROM HEATER
DISCHARGE FROM ECONOMIZER
FLUE GAS
DEGREES SUPERHEAT
AVG. STEAM PRESSURE

LUBRICANTS AND WASTE
CYL. OIL GALS.
ENG. OIL "
WASTE LBS.

COAL RECORD
LBS. ON HAND
LBS. RECEIVED
TOTAL
LBS. USED
LBS. ON HAND
TONS IN TRANSIT
TONS ON ORDER

LBS. COAL PER KW. H.
LBS. WATER PER KW. H.
LBS. WATER PER LB. COAL
LBS. COAL PER KW. H. FOR BANKING
PER CENT COAL USED FOR BANKING
WEIGHT OF ASH
PER CENT OF ASH

OPERATING RECORD. 21 HOUR AVERAGES.

	UNIT NO 1	UNIT NO. 2	UNIT NO. 3	UNIT NO. 10	UNIT NO. 11	UNIT NO. 12
AVG LOAD KW.						
MAX " "						
MAX " "						
AVG AMP PER PHASE						
MAX " " "						
MAX POWER FACTOR						
MIN " "						
AVG. MACHINE VOLTAGE						
AVG FREQUENCY						
AVG. STEAM PRESSURE						
" " TEMP.						
" SUPERHEAT						
" BAROMETER						
" RECEIVER PRESSURE						
" 1st STAGE						
" VACUUM AT EXHAUST						
" TEMP OF "						
" " CIRCULATING INTAKE						
" " " OUTLET						
" " HOTWELL						
" BEARING TEMP.						
No 1.						
" 2						
" 3						
" 4						
" 5						
" 6						
TEMP OIL TO COOLER						
" " FROM "						
HOURS CONDENSER TO HEATER						

REPORT BRIEFLY ANY TROUBLE WITH APPARATUS OR ANY APPARATUS OUT OF COMMISSION

FIG. 1. SAMPLE SHEET OF DAILY STATION LOG SHEET

every hour. The coal should be weighed as accurately as possible and a sample taken for every 50 tons burned. The refuse from the boilers should be weighed and a sample taken for every five tons. This test should last for a period of at least 48 hours, and notes should be kept of all operating conditions.

In the computation of the total water fed to the boilers (water fed to feed-water heaters plus the weight of the exhaust steam used to heat the feed water), the following formula can be used with very little error. Where

$$(Ws)(H - T_2) = (Ww)(T_2 - T_1) \text{ or}$$
$$(Wt - Ww)(H - T_2) = (Ww)(T_2 - T_1)$$

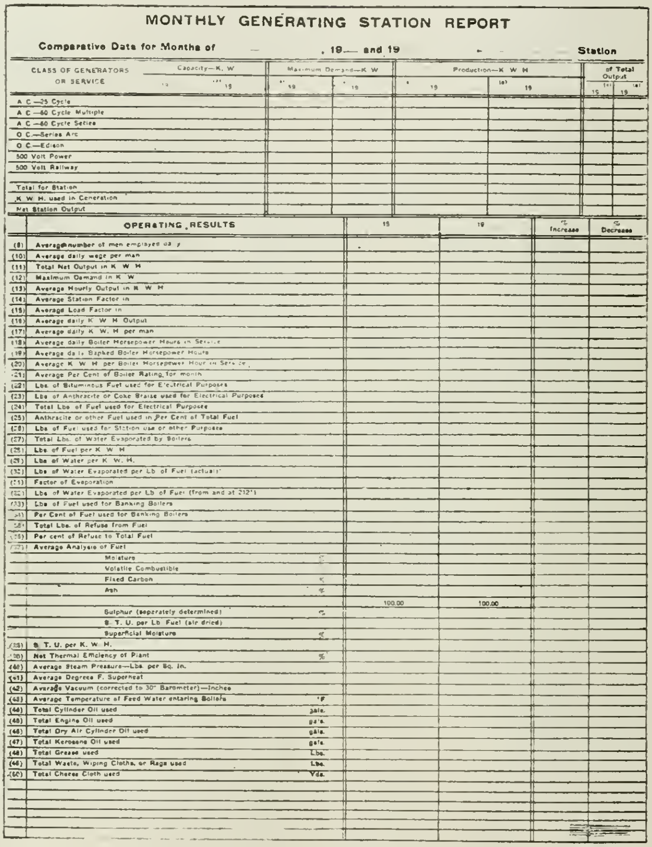
T_2 = Temperature of outlet water from heater; T_1 = Temperature of inlet water to heater; Wt = Total weight of the water and steam; Ww = Total weight of water; Ws = Total weight of steam; H = Total heat of exhaust steam.

Allowance should also be made for the height of water in the heater and below the starting levels of the same.

This test, when properly computed and rightly arranged (both in data and curve form), should show the following data on the operation of the station: Pounds of steam per kilowatt-hour; pounds of coal per kilowatt-hour; pounds of steam per pound of coal (actual and from and at); average temperature of steam; average steam pressure; temperature of boiler-feed water; temperature of water fed to heaters; temperature of flue gases to economizers; temperature rise of feed water in open heater; temperature rise of water in economizers; per cent. of boiler rating; kilowatt-hours per brake horsepower (maximum, minimum, average); B.t.u. per pound of coal; B.t.u. per pound of refuse; efficiency of boilers; B.t.u. per kilowatt-hour; and the net thermal efficiency of the power plant.

A table should be made up for future reference that will show the approximate losses in all parts of the station; for example, the following percentage losses were found, calculated or estimated in one plant:

	Per Cent
Combustible matter in ash	2.5
Radiation and leakage of boilers	5.0
Gases rejected to chimney	14.0
Blow-off losses	1.5
Radiation and leakage of steam piping	1.5
Friction loss in auxiliary and turbines	2.0
Rejected to condenser	58.0
Electrical losses	1.2
Required for auxiliaries	6.5
Loss in each pound of coal	92.2
Regained by sending condensate back to heater and reheating it with steam from auxiliaries	5.0
Total energy delivered to bus	12.8



MONTHLY GENERATING STATION REPORT

Comparative Data for Months of , 19— and 19 Station

CLASS OF GENERATORS OR SERVICE	Capacity—K. W. 19	19	Maximum Demand—K. W. 19	19	Production—K. W. H. 19	19	% of Total Output 19	19
A. C.—25 Cycle								
A. C.—60 Cycle Multiple								
A. C.—60 Cycle Series								
D. C.—Series Arc								
D. C.—Edison								
500 Volt Power								
500 Volt Railway								
Total for Station								
K. W. H. used in Generation								
Net Station Output								

	OPERATING RESULTS		19	19	% Increase	% Decrease
(9)	Average number of men employed daily					
(10)	Average daily wage per man					
(11)	Total Net Output in K. W. H.					
(12)	Maximum Demand in K. W.					
(13)	Average Hourly Output in K. W. H.					
(14)	Average Station Factor in					
(15)	Average Load Factor in					
(16)	Average daily K. W. H. Output					
(17)	Average daily K. W. H. per man					
(18)	Average daily Boiler Horsepower Hours in Service					
(19)	Average daily Banked Boiler Horsepower Hours					
(20)	Average K. W. H. per Boiler Horsepower Hour in Service					
(21)	Average Per Cent of Boiler Rating for month					
(22)	Lbs. of Bituminous Fuel used for Electrical Purposes					
(23)	Lbs. of Anthracite or Coke Braise used for Electrical Purposes					
(24)	Total Lbs. of Fuel used for Electrical Purposes					
(25)	Anthracite or other Fuel used in Per Cent of Total Fuel					
(26)	Lbs. of Fuel used for Station use or other Purposes					
(27)	Total Lbs. of Water Evaporated by Boilers					
(28)	Lbs. of Fuel per K. W. H.					
(29)	Lbs. of Water per K. W. H.					
(30)	Lbs. of Water Evaporated per Lb. of Fuel (actual)					
(31)	Factor of Evaporation					
(32)	Lbs. of Water Evaporated per Lb. of Fuel (from and at 212°)					
(33)	Lbs. of Fuel used for Banking Boilers					
(34)	Per Cent of Fuel used for Banking Boilers					
(35)	Total Lbs. of Refuse from Fuel					
(36)	Per cent of Refuse to Total Fuel					
(37)	Average Analysis of Fuel					
	Moisture	%				
	Volatile Combustible					
	Fixed Carbon	%				
	Ash	%				
			100.00	100.00		
	Sulphur (separately determined)	%				
	B. T. U. per Lb. Fuel (air dried)					
	Superficial Moisture	%				
(38)	B. T. U. per K. W. H.					
(39)	Net Thermal Efficiency of Plant	%				
(40)	Average Steam Pressure—Lbs. per Sq. In.					
(41)	Average Degrees F. Superheat					
(42)	Average Vacuum (corrected to 30" Barometer)—Inches					
(43)	Average Temperature of Feed Water entering Boilers	°F				
(44)	Total Cylinder Oil used	gals.				
(45)	Total Engine Oil used	gals.				
(46)	Total Dry Air Cylinder Oil used	gals.				
(47)	Total Kerosene Oil used	gals.				
(48)	Total Grease used	Lbs.				
(49)	Total Waste, Wiping Cloths, or Rags used	Lbs.				
(50)	Total Cheese Cloth used	Yds.				

FIG. 2. A COMPREHENSIVE MONTHLY GENERATING REPORT SHEET

Just as soon as the station test has been completed, turbine tests should be started. These should be run under operating conditions and should last a 24-hour period. The load on the turbine should be varied so as to cover all the working points of the turbine. The following readings should be taken: Output (read on the watt-hour meter), voltage, amperes per phase, field current, armature temperatures, steam pressure, temperature of steam, stage pressure, temperature of cooling air in and out of generator, vacuum at exhaust, in condenser and hotwell, barometer, temperature of circulating water in and out, temperature of hotwell and speed of all pumps.

The amount of steam used by the turbine can be obtained from either of two methods, but better by the use of both—steam-flow meter on the steam main, weighing the condensate. If the condensate shows higher than the steam-flow meter, then it is possible that some of the circulating water is leaking into the condensate; if the condensing water is salty, the amount of leakage can be determined by a salt test of the condensate and of the circulating water. Silver nitrate salt test is the most reliable way of testing for salt.

A turbine test, when properly made, should show the following data for all operating points of the turbine and condenser: Pounds of steam used per hour; pounds of steam used per kilowatt-hour; stage pressures; armature temperature; temperature rise of generator cooling air; vacuum (30-in. barometer); temperature rise of circulating water; temperature of condensate; inlet temperature of circulating water; outlet temperature of circulating water; temperature of vacuum; difference between temperature of vacuum and outlet water; difference between temperature of vacuum and hotwell; per cent. of vacuum; steam pressure; temperature of steam; gallons of circulating water per minute; and speed of all pumps.

These results should be shown graphically, and the condenser performance should be plotted to pounds of steam and not to kilowatt load. Figs. 7 and 8 show graphically the method of report tests for condensers and turbines respectively. All the main units should be tested in this manner and the steam consumption of all the auxiliaries should be determined. The auxiliaries can be tested with a portable steam-flow meter or a small portable condenser and weighing the condensate. Fig. 9 shows curves of a test on a boiler-feed pump.

As soon as all the main and auxiliary units have been tested, a composite water rate (that is, the main unit water rate plus the auxiliary water rate) should be made up for each unit on one sheet. This sheet should be given to the engineer and switchboard operators with instructions to carry the load on the most economical machines and at their best working points.

If an examination of the test results reveals the fact that all the units are not operating at their proper efficiency, an investigation should be started at once. First, the buckets or blades should be examined, and if they are found to be dirty they can be cleaned off by the injection of a few barrels of kerosene oil into the valve chest of the turbine when it is running at about half speed. The condensate should be dumped overboard until all traces of oil are out of it. This should be done to all turbines at least once every three months. Next, the condenser should be filled with water to determine if there are any air leaks in the condenser and turbine. If any leaks are present, the water will drop out of them and the location can be marked and repaired as soon as possible. The outside of the condenser tubes should be examined, and if a gum deposit is found on them the condenser should be filled up with a 4 or 5 per cent. solution of soda ash and boiled with steam for several hours. This will remove all foreign matter from the tubes and will not injure them in any way; but if the solution is of greater strength than 5 per cent., some action will be noticed on the tubes. The inside of the tubes should be examined, and if they are found to be dirty they should be cleaned at once.

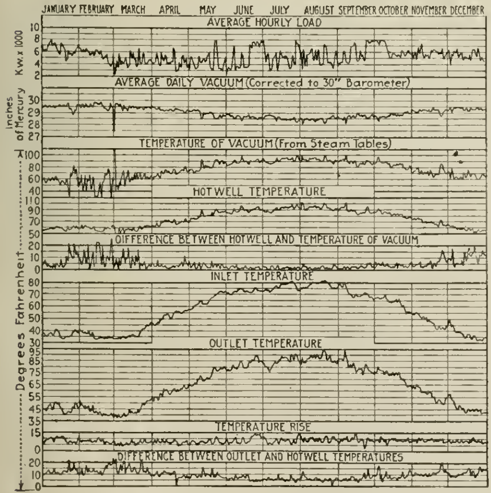


FIG. 3. CURVE SHOWING OPERATION OF SURFACE CONDENSER ON A 10,000-KV.-A. TURBINE

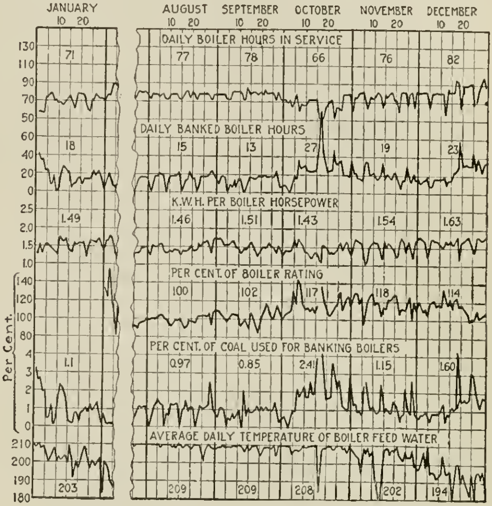


FIG. 4. YEARLY BOILER-ROOM CURVES

The cleaning of condensers should be a regular operating job; when to clean them can be told by the temperature rise of the circulating water. Fig. 10 is a curve showing the amount of circulating water needed for various temperature rises with varying amounts of steam condensed per hour.

When the inspection has been completed, the turbines should be tested again, and if they do not come up to their proper efficiency experiments should be started to determine if the design of the turbine or condenser can be changed to produce the desired efficiency.

At this point a test should be made to determine the effect of various vacua on the water rate of the turbine and also the effect of various sized air leaks on the vacuum. Fig. 11 is a curve that shows the effect of vacuum on the water rate of a 3000-kw. vertical turbine.

The next point to investigate would be that of the steam piping. A line diagram should be made of all the piping to determine if any changes can be made that will insure a more flexible piping system and if the piping is properly covered. The approximate relative value of different pipe coverings are:

Covering	Thickness, In.	B.t.u. Loss per Hour per Sq.Ft. per Degree of Average Difference in Temperature
Uncovered pipe		2.71
85 per cent. magnesia	1.18	0.418
85 per cent. magnesia, 2-in. section, ½ in. block	2.71	0.288
85 per cent. magnesia, two 1-in. sections	2.50	0.294
Hair felt	0.82	0.422
Rock wool	1.60	0.256
Mineral wool	1.30	0.285

A test should next be run on the open heaters to determine if they are properly doing their work. The following readings should be observed: Total water feed to heaters, total exhaust steam feed to heaters, temperature of exhaust steam, pressure of exhaust steam, height of water carried in heater, temperature of water feed to heater, temperature of water from heater. This test should last twenty-four hours. The various drips and traps that discharge into the heater should be placed so that they will discharge the water and steam into the heater without interfering with the flow of inlet water to the heater pans.

The boilers should be tested; that is, each type of boiler and stoker in use in the plant should have a complete test made on it. First, a maximum capacity test, which should last for at least four hours. Next, a series of tests, each of four hours' duration, should be made with varying draft pressures, so that when all the tests are completed curves can be made up for the entire operating range of the boiler and stoker. The following facts should be determined or read in every boiler test, and curves should be made for each item: Pounds of coal burned per hour; pounds of coal burned per square foot of grate surface; pounds of air per pound of combustible; percentage of ash and refuse to total coal burned; coal analysis (sample for every ten tons of coal burned); ash analysis (sample for every two tons of ash); flue-gas analysis (gas sample taken every ten minutes); draft between boiler and damper; draft in furnace (over the fire); draft in ashpit; draft readings along the flow of the gases; temperature of furnace; temperatures along the flow of gases; temperature of gases in uptake; temperature of steam; temperature of boiler-feed water; pressure of steam; pounds of water evaporated per hour; percentage of boiler rating; apparent evaporation; equivalent evaporation; equivalent evaporation per square foot of heating surface; efficiency of boiler in percentage; efficiency of boiler and furnace; efficiency of gasification of fuel; cost of steam per 1000 lb.; and method of firing; that is, thickness of fire, speed of stoker shafting, etc.

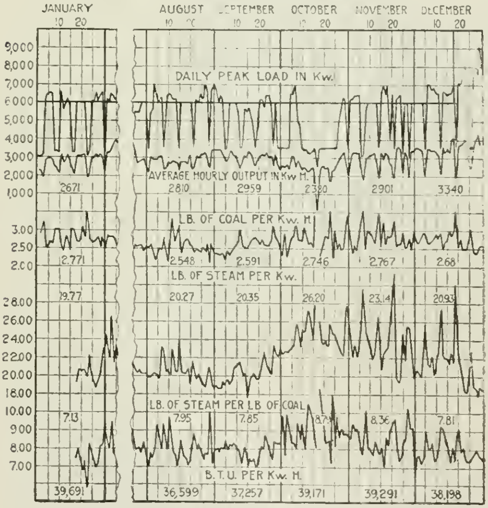


FIG. 5. YEARLY STATION CURVE

The boiler setting should be examined for tightness and proper heat insulation, and if any air leaks are found they should be stopped at once. The tubes should be inspected for cleanliness both inside and outside. Draft and temperature readings should be taken on each boiler along the flow of gases to determine if the baffles and bridge-walls are in good condition. In Fig. 12 two curves are given which show the temperatures obtained with good and bad baffles. The top curve shows that the baffles are in good shape; the bottom curve indicates that the baffle between the first and second pass is bad.

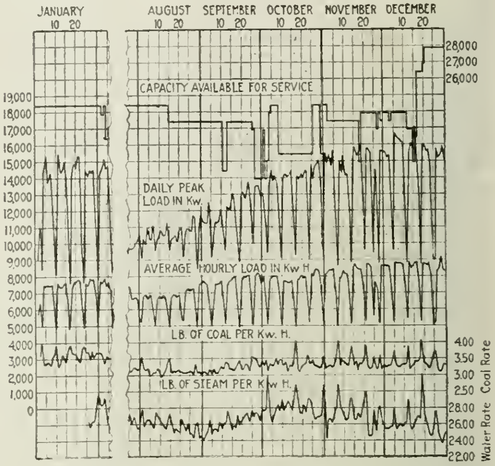


FIG. 6. YEARLY DIVISION LOAD CURVES

The design and construction of the furnace should be examined. No precise rule can be made for the design of the furnace, as local plant conditions, such as quality of coal, force of draft, etc., will greatly affect the design. In regard to the material used in the construction, it will be found that a poor quality of brick that is uniform as to size will outlast a good quality that is not uniform. It has been found that the best baffle is constructed of two courses of firebrick with a $\frac{1}{2}$-in. section of asbestos millboard between the brick.

A test should be run to determine the actual amount of coal per brake horsepower per hour that is necessary to properly bank a boiler; that is, to keep it up to boiler pressure. This test should last at least 24 hours to avoid the error due to the heat being stored up in the boiler settings. The following table shows the approximate amounts of coal needed per hour to properly bank various types of boilers:

	Lb. per Hour
Babcock & Wilcox boiler, Roney stoker, 600 b.hp	162
Babcock & Wilcox boiler, Bayonne stoker, 600 b.hp	201
Edge Moor boiler, hand-fired, 600 b.hp	115
Heine boiler, 300 b.hp.	53
Stewart boiler, 150 b.hp	19

A table should be prepared showing the rating at which it is desired to operate the boilers. This table should show the following items in regards to operating points: Draft at damper, draft over the fire, draft in ashpit, speed of stoker shafting, thickness of fires, how often to clean fires, water level in boilers, pounds of coal required to bank each type of boiler per hour, how often the boilers are to be blown down (this point should be determined by a daily salt test on the boilers, a safe working figure for boilers being 25 to 30 grains per U. S. gallon, while for condensers the salt should not run over 5 to 6 grains per U. S. gallon), when tubes are to be cleaned, and the number of boilers required for various loads. This table should be given to the boiler-room engineer and a man placed in the boiler room to instruct the engineer and firemen in regard to the instructions and to see that they are carried out.

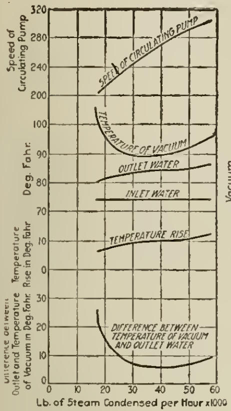


FIG. 7. CURVES OF CONDENSER TEST

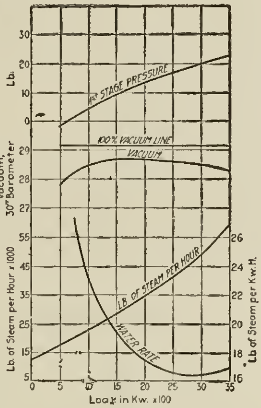


FIG. 8. CURVES OF TURBINE TEST

Care should be exercised to see that at all times the boiler feed-water temperature is carried at the highest figure possible. If at times it is found that too much or too little steam is obtained for heating the feed water, then it is advisable to install a heat-balance valve on one of the turbines, or on as many as are needed. This valve will take steam from or deliver steam to the secondary stages of the turbine and will maintain the proper amount of steam in the exhaust-steam main. Or it may be found that a great deal of hot water is being lost because the open heater is overflowing. If a water seal is put on the overflow line, it will be found to remedy this trouble. Fig. 13 shows the saving in per cent. due to increased feed-water temperature.

A series of tests should be run to determine the right kind of oil for the various machines that are to be lubricated. The results obtained from these tests should be of such a nature that specifications for the purchase of oil can be made from the data obtained. Oil specifications should contain at the least the following items: Composition; per cent. of free acid; specific gravity at 27.6 deg. C.; flashing point, deg. C.; burning point, deg. C.; chill point, deg. C.; loss at 80 deg. C. in five hours; viscosity, compared to water at various temperatures; gumming value, distance flowed down a glass plane; grade of 3½ per cent. and coefficient of friction.

As a general rule a large amount of oil can be saved or reclaimed by the use of any of the oil and waste cleaners on the market; the oil obtained from the cleaner or press can be filtered and used again in various machines that do not require first-class oil.

With regard to the maintenance of the various units in the plant it will be found that if a systematic method of testing and inspection of all units is put in operation, the maintenance cost will be reduced to a minimum, but if by increasing the maintenance cost the operating cost can be reduced, the net result will be a decreased current cost. The installation of a good machine shop will enable many repairs to be made at a reduction in cost, because parts can be made when other work is slack, and then repairs can be made the instant they are needed; also in a power-plant machine shop a small overhead cost is possible.

The labor problem in power-station work is one that demands study, but in most cases it will be found that if a diagrammatic sketch is made up, showing the duties of each man and the location of the units he is to look after, it will enable one to decide if the duties are rightly apportioned.

If it is possible at any time to shut down the plant for a period of ten hours, a test should be made to determine the amount of steam that is necessary to take care of the leaks and radiation. This test is generally made as follows: First, all the boilers are filled—that is, each boiler should have a full glass of water—then all the pumps are shut down and enough fire is kept under the boilers to keep the steam up to working pressure. Care should be taken that the safety valves do not blow and that the blowoff valves do not leak. Readings should be taken every hour of the height of water in the drums and of the amount of coal used, notes should be taken of all leaks that are observed in any part of the plant. The amount of steam necessary to take care of the leaks and radiation in the plant can be calculated from the number of inches of water used up in the boilers. This test is not absolutely accurate, but it will be found to be a good approximation of these losses.

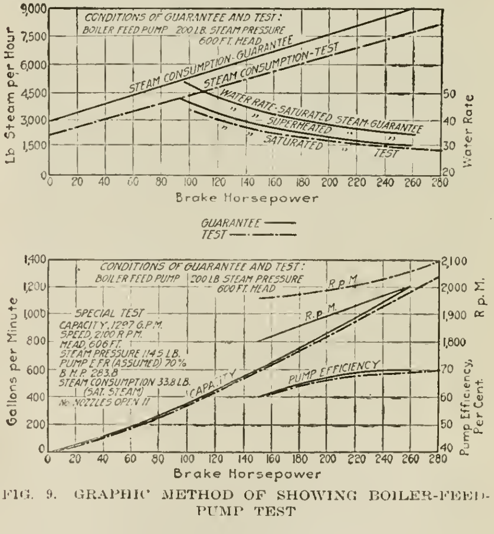


FIG. 9. GRAPHIC METHOD OF SHOWING BOILER-FEED-PUMP TEST

If the total pounds of coal and total pounds of water used daily for a period of a year are available, some valuable curves can be obtained by spotting the foregoing figures against the daily output. These curves will show the coal rate and water rate and evaporation for varying outputs and will also show the pounds of coal and water used daily to be ready to pick up the load. They can be used to determine whether the station is running at a better efficiency than it was in the year the curves where made. See Fig. 14.

Cost data play an important part in power-station work; that is, the cost sheet shows the results of all attempts made to run the station in an efficient manner. A cost system should be devised in detail, so that there can be no doubt as to the proper account each bill should be charged to or against. The monthly cost of current is simply an indication as to the approximate cost of current. This is due to the fact that in a great many cases work done in one month is often not charged out till the following month, and bills for material do not arrive in time to charge them to the proper month. The yearly cost can be made very accurate if attention is given to it. The various accounts that are generally used in a power station cost system and what charges are charged to each account follow in brief form:

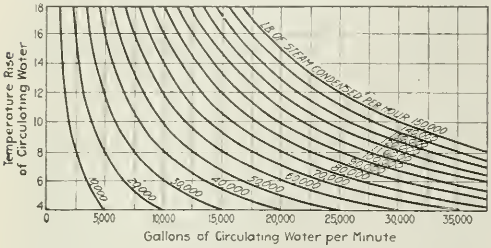


FIG. 10. CIRCULATING WATER REQUIRED FOR TEMPERATURE RISE WITH VARIOUS AMOUNT OF STEAM CONDENSED PER HOUR

The boiler-room labor account should include the cost of labor in the boiler room and elsewhere about the premises having to do with the making of steam.

The turbine or engine-room labor account should include the labor of the chief engineer, engineers, helpers, oilers, wipers, machinists, etc.

The account relating to electrical labor includes the cost of all labor in connection with the electrical generating apparatus and devices, beginning with the generators direct-connected or belted to prime movers and including the switchboard, feeder terminal board, and to where the electrical current leaves the station for transmission and distribution.

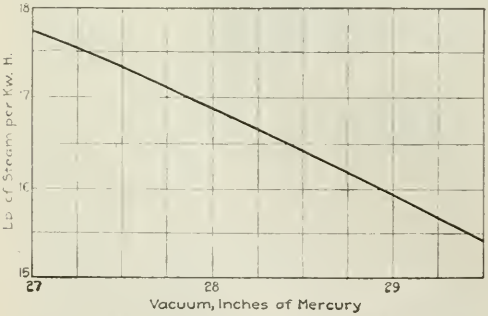


FIG. 11. CURVE SHOWING EFFECT OF VACUUM ON TURBINE WATER RATE

Supervision includes salaries and personal expenses of superintendents and assistants, general operating officials and general engineering staff chargeable to operation.

Operating labor includes the sum of all the aforementioned accounts, plus clerks' hire, janitors and watchmen.

The coal account includes the cost of fuel and all labor expended on it till it reaches the bunkers; water account includes the cost of water for feed water and condensers, also the cost of boiler compound; lubricants account includes the cost of grease, engine oil, cylinder oil, dynamo oil, graphite, freight and cartage. The miscellaneous-material account is for material which the accounts mentioned do not cover. The total operating-material account is the total of all operating-material accounts, and the total operation is the sum of operating labor and material.

Building labor and material account includes the labor and material used in making repairs to buildings and structures used for power-station purposes. Boiler-room labor and material account includes the labor and material charges of repairing boilers, furnaces and auxiliary apparatus, such as feed-water pumps, blower engines and fans, coal conveyors, filters, heaters, economizers, stoker engines, etc. Turbine-room labor and material account includes the labor and material used in making repairs to steam turbines, condensers, air, circulating and oil pumps. Electrical labor and material includes the labor and material charges on all electrical apparatus. Piping labor and material account includes all labor and material charges on the piping system. Miscellaneous labor and material account includes charges not covered by the foregoing accounts.

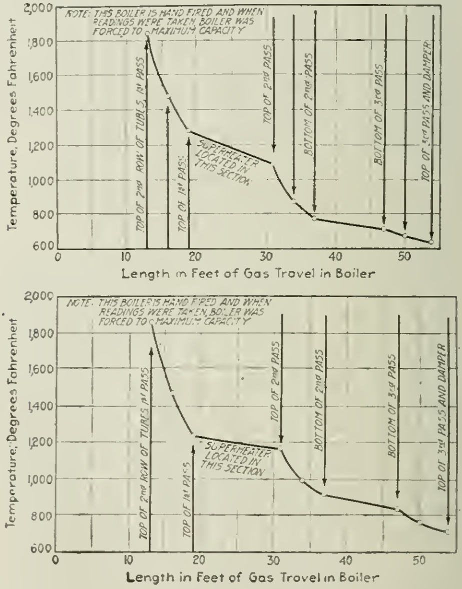


FIG. 12. CURVES SHOWING TEMPERATURES IN BOILER PASSES

Total maintenance labor is the total of all labor charges for maintenance. Total maintenance material is the total of all material charges for maintenance. Total maintenance is the sum of maintenance labor and material.

Total current cost is the sum of all labor and material expended in the generation of power.

Cost per kilowatt-hour is the total cost of current divided by the total output, minus the current used in the generation of current. Pounds of coal per kilowatt-hours is the total pounds of coal used divided by the total output, minus the current used in the generation of current. Cost of coal per ton (2000 lb.) is the total cost of the coal account divided by the number of tons of coal used.

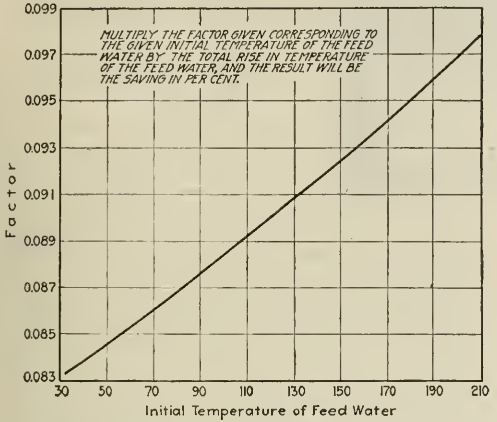


FIG. 13. CURVE SHOWING SAVING IN PER CENT. DUE TO INCREASED FEED-WATER TEMPERATURE

It is of value to know the percentage distribution of the current cost in the various departments, for it enables the engineer in charge to tell the amount of his time that should be devoted to each department.

TABLE 1. PERCENTAGE DISTRIBUTION OF CURRENT COST IN VARIOUS POWER STATIONS

Name of Account	Plant A	Plant B	Plant C	Plant D	Plant E	Plant F
Operation						
Labor:						
Boiler room	7.920	8.555	9.109	14.698	4.673	8.976
Turbine room	3.564	3.042	6.275	5.921	2.702	4.737
Electrical	3.366	0.950	1.215	2.172	1 019	2.521
Supervision, janitors, watchmen	4.356	1.331	1.215	4 436	1.085	0.180
Material:						
Coal	64.158	63.118	70.648	44.765	77.453	66.214
Water	1.980	6.273	0.202	2.011	0.709	3.463
Lubricants	0.396	0.380	0.405	0.558	0.243	0.734
Miscellaneous material	0.792	0.190	1.215	1.723	1.463	0.997
Miscellaneous charges	0.198	1.521	1 012	.....	.....	..
Maintenance						
Labor:						
Building	0.198	0.570	0.607	0.383	0 664	0.152
Boiler room	2.376	2.281	0.809	1.165	1.107	1.593
Turbine room	0.396	0 571	0.202	0.543	0.111	0.346
Auxiliary apparatus	1.386	0.762	0.405	1.931	0.243	1.510
Electrical	0.594	0.380	0.000	0.255	0.089	1.565
Piping	0 000	0.380	0 405	1.835	0.310	0.526
Miscellaneous	0.198	0 190	0 202	0.000	0.000	0.222
Material:						
Building	0 396	0.380	0.202	2.127	1.373	0.000
Boiler room	2.376	6.273	1.417	2.170	3.610	1.053
Turbine room	0.198	0.571	0.202	0.192	0.000	0.678
Auxiliary apparatus	0.594	0 762	0.809	2.106	0.399	0.858
Electrical	0.000	0 574	0.405	0.144	0.975	3.546
Piping	0 000	0.190	0.809	7.804	0.266	0.152
Miscellaneous	0 396	0.190	0 607	0.000	0.022	0.000
Total operating labor	19.208	13.878	17.814	27.226	9.479	16.415
Total operating material	67.525	71.483	73.481	49.058	79.867	71.408
Total operation	86.732	85.361	91.295	76.284	89.346	87.823
Total maintenance labor	5.148	5.134	2.631	6.112	2.525	5 887
Total maintenance material	3.960	8.938	4.453	12.544	6.644	6 288
Total maintenance	9.108	14.072	7.084	18.656	9.169	12 19
Other charges to power station account	4 159	0.571	1.620	5.060	1.484	0 000
Total cost of current	100	100	100	100	100	100
Coal per kw.-hr., lb	2.72	2.81	3.004	3.5171	2.443	3.23
Cost of coal per ton (2,000 lb.)	\$2.38	\$2.377	\$2.32	\$1.61	\$2.715	\$2.959
Average daily output (kw.-hr.)	261,400	329,800	90,800	131,100	638,300	166,300
Total cost of current compared to Plant E, per cent	112	111	109	139	100	160

In Table I the percentage-cost distribution for several power stations is given. It will be seen that local conditions or differences of operation greatly affect the current cost.

In Table II two years are compared. In the first year no attempt had been made to operate the power station in an efficient manner; in the second year a systematic scheme for the operation of the station was started. This table shows just what was done in each department and what results were accomplished, and the results obtained were convincing enough to decide that the right method for the operation of this particular station had been found.

TABLE II. COMPARATIVE YEARLY COST SHEET, PLANT "E"

Name of Account	Year, Per Cent.	Year, Per Cent.	Per Cent. Increase	Per Cent. Decrease
Operation				
Labor:				
Boiler room	4.673	4.187	......	16.587
Turbine room	2.702	3.164	9.024	.....
Electrical	1.019	1.025	......	6.522
Supervisioo, janitors, etc	1.085	1.213	4.082	......
Material:				
Coal	77.453	76.260	......	8.321
Water	0.709	0.666	......	12.500
Lubricants	0.243	0.285	9.090	......
Miscellaneous material	1.463	1.401	......	10.606
Maintenance				
Labor:				
Building	0.664	0.856	20.000	.....
Boiler room	1.107	1.142	......	4.00
Turbine room	0.111	0.190	60.000	......
Auxiliary apparatus	0.243	0 499	90.000	......
Electrical	0.089	0.095	......	......
Piping	0.310	0.594	78.571	......
Material:				
Building	1.373	0.737	......	50.000
Boiler room	3.610	3.300	......	14.110
Turbine room	0.000	0.119	......	.....
Auxiliary apparatus	0.399	1 261	194.44	......
Electrical	0.975	0.689	......	34.091
Piping	0.266	0.807	183.330	.....
Miscellaneous	0.022	0.024	......	.....
Total operating labor	9.479	9.586	5.841	......
Total operating material	79.8670	78.615	......	8.348
Total operation	89.346	88.201	......	8.081
Total maintenance labor	2.525	3.377	24.561	......
Total maintenance material	6.644	6 969	2.33	......
Total maintensnce	9.169	10.347	5.072	.....
Total decrease in current cost	......	6.880	......	.....
Lb. of coal per kw.-hr	2.443	2.210	......	9.537
Average daily output, kw.-hr.	638,300	744,470	16.616	.....
Cost of coal per ton of 2,000 lb.	\$2.715	\$2.783	2.505	......

All the foregoing figures are percentage figures of the cost per kw.-hr.

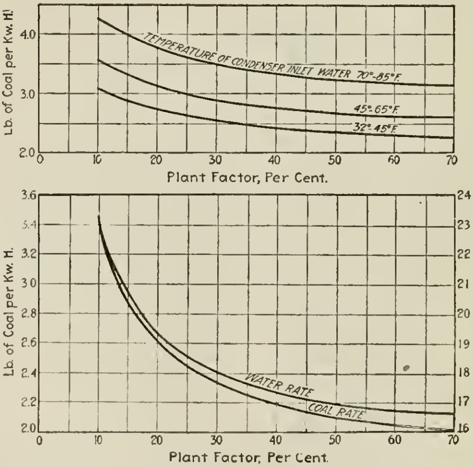
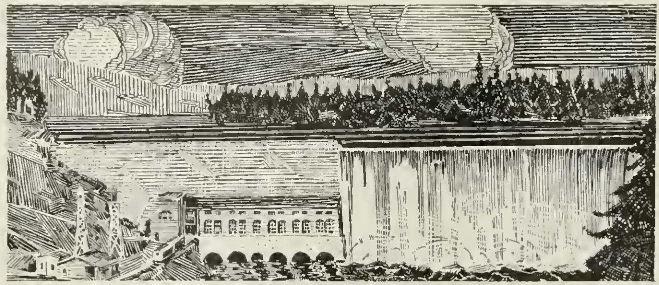


FIG. 11. VARIATION OF COAL AND WATER RATES WITH THE PLANT FACTOR

The methods mentioned in this article do not necessarily hold for all plants, but they are presented as suggestions for those who are desirous of working up power-plant data.



POP'S WATER-POWER COURSE

By

John S. Carpenter

"SHALL we talk about the plain an' needle nozzle, along with somethin' on the Pelton bucket?" asked Pop of Jimmy.

"You know me, Pop. I'm strong for your hydraulic chatter any time."

"That bein' the case, son, we'll tear loose. This critter I'm a-drawin' (Fig. 1) is a plain nozzle. This is the most primitive form for deliverin' water to a wheel an' also the cheapest. The inlet is made large enough to let the water pass with a velocity not exceedin' about that due to 3 per cent. of the head. At the discharge they usually 'lows about 2 per cent. more area than is theoretically needed so as to make some allowance for friction, it bein' gen'ly assumed that the velocity is less by 2 per cent. an' addin' the extry area lets the full water quantity through. The smallest area of the nozzle is made short, and then it should increase quite rapidly in diameter with a nice easy curve. The inside should be bored out an' then polished so that the friction, which increases as the square of the velocity an' directly as the roughness coefficient, is kept low."

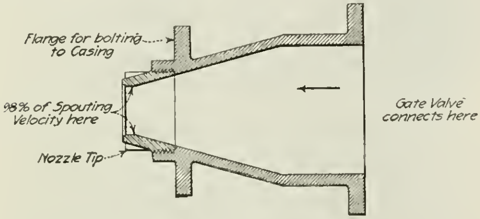


FIG. 1. PLAIN NOZZLE

"Can they regulate the size of the stream in a plain nozzle like this with some sort of a shutter like that on a camera? With such a hickey it would seem that you could get any size stream within the range of the nozzle diameter."

"They tried that very thing," declared Pop, "along with half a hundred other things that looked promisin'. The main trouble with the critter you jes' proposed is that the pressure, when it is anything at all, is likely to blow the hull dern thing to smithereens, not to speak of such triflin' faults as leakage when closed and stream distortion at almost any openin'. Any device that proposes to shet off the water supply abruptly, by which I means by throttling with a thing on the gate-valve principle, you can bank on as bein' all bunk. Them things has all the benefits of a sudden contraction in 'em in some shape or other an' it never fails to produce whirls an' eddies in the flow."

"Then what kind of a thing can be used to regulate the area of the stream without distortion of the jet and making a lot of friction?"

"Your question leads up quite purty to the needle nozzle. This sketch (Fig. 2) almost explains itself. The idee is that the bulb-shaped dingus is moved in or out as you wants to increase or decrease the size of the stream or jet. It gives an idea of the proportions of the thing with the figgers on the sketch, based on the size of the jet needed by the wheel. A few degrees change in the angles or a little difference in the proportions would never be so serious as to affect the good qualities of the nozzle so long as the point of inflection of the bulb—which is the place marked *A* where the curvature of the bulb changes from convex to concave—is inside of the bore of the tip. The other important fact about this thing is that it should be bored out to a true curve and then polished. The high velocities and the fact that the water often carries sand sometimes plays the divil with the nozzle tips; so in such cases they makes them of steel castings or very tough bronze. The needles are usually made of machinery steel unless the water carries acid in solution. When you see a needle badly worn or eroded at the business end, you can usually bet on it that the point of inflection has been outside of the nozzle bore or that the bore has been worn large by sand and the needle worked its way through."

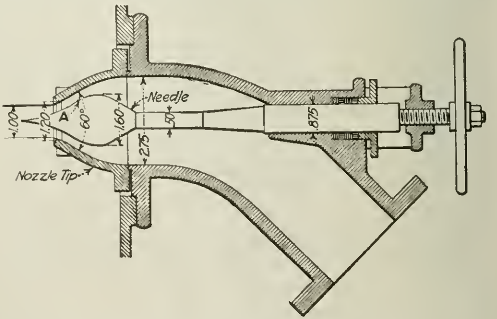


FIG. 2. SECTION THROUGH NEEDLE NOZZLE

"I suppose that the handwheel mechanism that you show is something like that of a gate valve," Jimmy suggested.

"Yep, it can be used like that an' in lotsa other ways. For instance, you might cut teeth in the rim of the handwheel and work it with another gear from a distance, or you could connect the needle direct to the governor lever as it is often done when pipe-line conditions and the rotating masses of the generator and wheel are heavy enough. This will be taken up more fully later on when we goes to the subject of governors and speed regulation."

Pop reached over to his coat and dragged out four long, black cigars which he distributed among the notables present and proceeded to light. Having engulfed about half of his, Jimmy could think much better.

"And now," snoozled Pop between his teeth and cigar, "we'll talk about the buckets (see Fig. 3). When you look at the thing, it seems so dern simple that you wonder why perfessors make so much mathematics over it; but when you come to make a strict analysis of the design, you'll find it's a pretty complicated thing, and the old sayin' is true that they's a direct proportion between the simplicity of the article an' the amount of brainwork needed to git it to that stage.

"Now about the material for makin' buckets. Cast iron is used for heads up to about 400 ft., an' bronze above that. When the water is acid at any head, they uses bronze with proper alloys for strength to suit the head. Small buckets are usually made of bronze or brass, 'cause the brass takes a thinner cast edge than iron will an' is easier to machine. When the water carries sand or grit, cast steel is gen'ly used, except in the case of real small buckets which would be made of very tough bronze. They was a guy which tried to git one of the high-class builders of the Pelton wheel to make 'em outa pressed steel, an' the idee ain't so dern bad at that. But it was canned 'cause they'd have to have a steel die for nearly every order, since most all of 'em is special, an' steel dies is worth near their weight in gold. He probably got his idee from seein' some turbine manufacturer make his runner vanes outa stovepipe plate an' saw that they could bend the plate to fit the form quite nicely when hot.

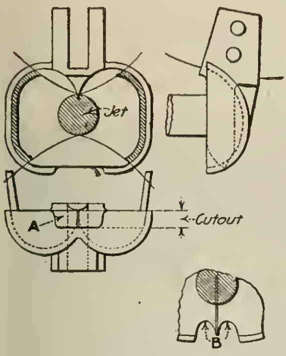


FIG. 3. SHAPE OF BUCKET BLADES AND CUTOUT

"Then they has made the wheels with the buckets cast solid with the wheel, a notable case bein' a wheel at the Colorado Fuel and Iron Co.'s works, where they has a wheel some 8 ft. in diameter, and a jet on it about 8 in. in diameter—a real high-head job. They is practical difficulties in the makin' of wheels like this 'cause in the pourin' of the mold the dirt in the iron or steel rises to the top, and then if one doesn't keep his fingers crossed, one side of the buckets will be spongy and dirty iron, helpin' erosion a great deal. If one bucket should be defective in that the iron didn't run well and fill the cores, the hull wheel would have to be scrapped, a big loss in money an' time. They has used other methods of casting the buckets—for instance, in twos and threes—but it costs high."

"What is that dingus you show in Fig. 4?" Jimmy was curious to know.

"That is a section through two buckets showin' about how the water discharges from the sides. In order that the water will enter the wheel properly, which means without shock, they has to cut away the front of the bucket as I shows at *A*, Fig. 3. That cutout must be deep enough to join on with the curvature in the inside of the buckets without any bumps or lumps, the shape of the bucket inside bein' sich that you can pass a section through it at any place and it must show a smooth an' gentle curve. One designer makes the cutout like I shows at *B*, which modern practice has discarded, 'cause it has been learned that they is water escapin' through that cranny at *B* in certain positions of the bucket as it turns around, all this bein' proved by means of instantaneous photographs. Now, Fig. 3 shows what is claimed to be the most perfect shape and form. Some will prob'ly come back an' say it ain't, and that the ellipsoidal form is more correct. One great objection to the last-named is that the dischargin' water from the sides will twist like the nodes in a vibratin' string or wire, causing interference with the precedin' bucket back, because the distance betweeen the nodes or twists is dependent on the head on the jet, an' you can't tell just when the nodes will strike agin the followin' bucket. You can prove this by placing a spoon in the stream running from a faucet showin' how the stream will twist."

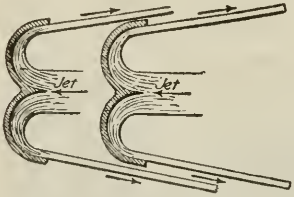


FIG. 4. SECTION THROUGH TWO BUCKETS

"Then I suppose that a bucket with straight sides all the way would be the right thing," Jimmy suggested.

"No, that has been tried for a good many years. That shape is showed in Fig. 5, showin' both the ellipsoidal and the Blue bucket, which is the name of the kind you last spoke about. With the Blue bucket the water has a tendency to bank up in the corners and havin' the same objection as on the ellipsoidal design. These bad points can be certainly avoided by havin' a very large bucket so that the thickness of the water sheet is small, but that increases the friction. In the Jackson style bucket, shown in Fig. 3, we has a combination of the best points of both the other styles, an' I might add that this shape has been thoroughly tested in over 1500 individual tests in Europe, so its characteristics is purty well known. But don't git the idee the ellipsoidal bucket is a failure, 'cause it is far from that. In many cases it has shown very good efficiencies, but the Jackson style seems to show up better. Nowadays all the leadin' builders make the style shown at the left in Fig. 3, with but little change. Some will combine the shape of cutout at *A* with that at *B*, but them fellers is mostly of the German branch of design, an' hardly the up-to-date branch at that."

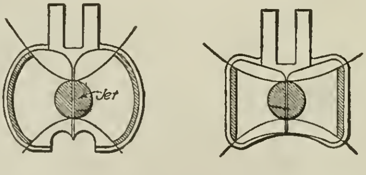


FIG. 5. ELLIPSOIDAL AND BLUE BUCKETS

Flywheel Explosion at Norwood, Ohio

About 7:45 p.m. on Sept. 15 the explosion of a gas engine flywheel in the municipal power plant at Norwood, Ohio, did considerable direct damage, and fire which resulted from the escaping gas practically ruined a great deal of the machinery. The estimated damage is $50,000, and this is considered to be on a pre-war price basis by some observers.

The unit causing the accident was a four-cylinder opposed gas engine, direct-connected to a 175-kw. 250-volt d.c. generator. At right angles to this engine was a four-valve single-cylinder steam engine direct-connected to a 200-kw. generator. There were also two tandem compound steam engines each direct-connected to a 100-kw. generator, as well as a 30-kw. motor-generator set.

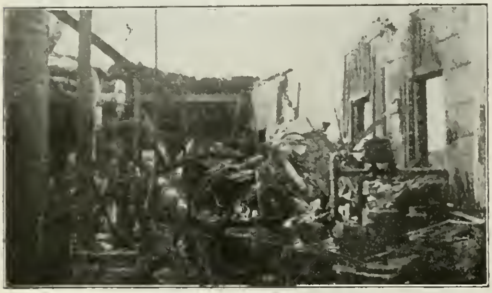


FIG. 1. THE WRECKED GAS ENGINE

According to the operator on duty, the No. 2 cylinder on the gas engine had been missing for some time, and he had been working on it up to a few minutes before the accident. It was apparently working better, and the operator started to go to another part of the plant when this cylinder seemed to backfire. This appears to have damaged the governor, for the engine at once began to speed up very rapidly. The operator was only a few feet away at the time, but the engine was picking up so rapidly that before he could go around the engine and shut off the gas, the speed was so high that he deemed it unsafe to try to reach the valve. His judgment seems to have saved his life, for before he could have reached the valve the flywheel let go. The explosion broke some of the gas connections, releasing a six-inch natural-gas main. The gas almost immediately took fire.

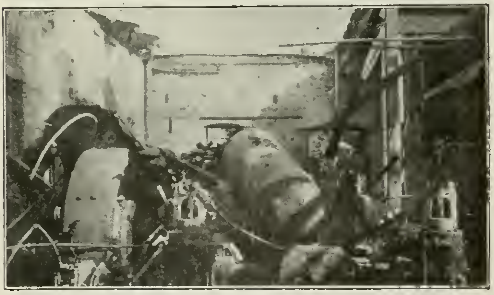


FIG. 2. THE GAS ENGINE AND GENERATOR

Pieces of the broken flywheel were thrown up through the roof and south of the power house to the B. & O. R.R. tracks, a distance of about 300 yards. Other pieces tore out a portion of the north wall and were found fully 100 yards away.

The four-valve steam engine, the plane of whose flywheel was east and west, also ran away, probably due to some wreckage of the building falling on the governor. This flywheel exploded, throwing one piece eastward over the top of the boiler room and nearly 100 yards away. Another piece was thrown westwardly about 200 yards and onto the roof of a four-story building. Fortunately, the roof was strong enough to support the shock with little damage. Meanwhile the two tandem compound engines were shut down by the operator.

A large part of the damage resulted from the fire. Street repairs were going on, and some of the material was piled over the street valve in the gas main. For this reason the attendants were unable to shut off the gas for some little time.

The gas engine that caused the trouble is apparently damaged beyond repair, it being, of course, in the hottest part of the fire. Except for its flywheel and a few minor parts, the four-valve engine appears to have suffered very little, either from the explosions or the fire.

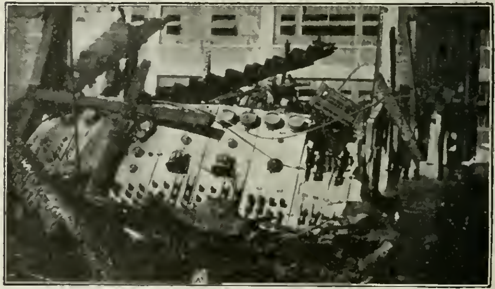


FIG. 3. THE WRECKED SWITCHBOARD

The tandem compound engines were only slightly damaged by fire. The four generators and the motor-generator set will be almost a total loss as their insulation was completely burned off. The switchboard was badly wrecked by the fire and by part of the roof falling on it. The damage to the steam piping does not appear to be very great. Considerable repairs will be required for the walls, and the roof, which was of frame construction, will have to be almost entirely rebuilt. Two a.c. units, the pumps and air compressors were damaged very little. The boiler room was untouched.

The operator's account of the events at the time of the accident, as given here, is verified by the oiler and seems to be borne out by what could be seen at the plant shortly after the accident.

Fig. 1 shows part of the gas engine under the pile of débris. Fig. 2, taken from the opposite direction, shows more of the gas engine with its generator. Fig. 3 shows the wrecked switchboard as well as some of the charred roof timbers.

Until repairs can be made Norwood is being supplied with water from the Cincinnati water works and with electric current from the Union Gas and Electric Company.

The Electrical Study Course—Power and Power Factor

The problem in the previous lesson is worked out and then the explanation is continued to show how to calculate power and power factor in a single-phase alternating-current circuit.

IN THE previous lesson the problem given was: 240 amperes flows through a coil of wire when connected across a 120-volt direct-current circuit, but when connected on 210-volts alternating current 300 amperes passes through the coil. Find the ohmic resistance R, impedance Z, reactance X in the coil, volts necessary to overcome the resistance and the reactance of the coil.

When the coil is connected to a direct-current circuit, the current flow is limited by the ohmic resistance only, consequently the resistance of the coil may be found by Ohm's law, $R = \frac{E}{I} = \frac{120}{240} = 0.5$ ohm.

When the coil is connected on an alternating-current circuit, the current is limited by the impedance Z of the circuit and, as explained in the previous lesson, $Z = \frac{E}{I}$, in this problem equals $\frac{210}{300} = 0.7$ ohm. The inductance ohms $X = \sqrt{Z^2 - R^2}$, in our problem $X = \sqrt{0.7^2 - 0.5^2} = 0.490$. The voltage E_R necessary to cause the current to flow through the ohmic resistance of the circuit is equal to the resistance in ohms times the current (Ohm's law is in direct current). That is $E_R = RI = 0.5 \times 300 = 150$ volts, and the voltage E_X necessary to overcome the inductance of the circuit is equal to the inductance in ohms times the current, or $E_X = XI = 0.49 \times 300 = 147$ volts. As was explained in the previous lesson, the inductance volts are 90 deg. out of phase with the volts causing the current to flow through the resistance of the circuit, and the relation may be shown in a right triangle as in Fig. 1. Then the volts $E = \sqrt{E^2_R + E^2_X} = \sqrt{150^2 + 147^2} = 210$ volts, which checks up with the volts assumed.

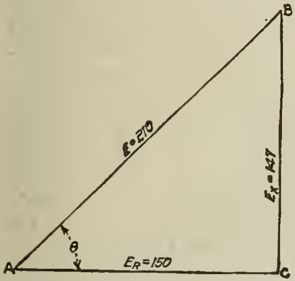


FIG. 1. RELATION BETWEEN TERMINAL, RESISTANCE AND INDUCTANCE VOLTS

The question now arises, What is the wattage equal to? Is it the voltmeter reading times the ammeter reading, Fig. 2; that is , $EI = 210 \times 300 = 63{,}000$? The answer is no, if there is inductance in the circuit as in this case. In the direct-current circuit the total power is equal to the square of the current in amperes times the resistance in ohms; that is, the watts $W = I^2R$. Then in the problem in question $W = 300 \times 300 \times 0.5 = 45{,}000$ watts. The value obtained by the product of the volts and amperes in an alternating-current circuit is called the apparent watts. We hereby have that the apparent watts equal 63,000, where the actual watts equal only 45,000. If we divide the apparent watts into the actual watts, we get a factor that is called the power factor of the circuit. The power factor in the case under consideration is $45{,}000 \div 63{,}000 = 0.714$.

The actual watts, which in our problem are 45,000, are what the wattmeter would indicate. The wattmeter reading is sometimes called the true watts. Since the power factor equals the actual watts divided by the apparent watts, it must also equal the wattmeter reading divided by (voltmeter reading × ammeter reading). From the preceding it is evident that the watts in a single-phase alternating-current circuit are equal to volts multiplied by amperes × power factor. Power factor is generally abbreviated *P.F.* Therefore the expression for watts in a single-phase alternating-current circuit is $W = EI \times P.F.$ Applying this in our problem, we have $W = 210 \times 300 \times 0.714 = 44982$ watts.

Power factor is frequently given in percentage. In such a case its value is multiplied by 100. Thus in the foregoing example the power factor could be given as $0.714 \times 100 = 71.4$ per cent. power factor. The apparent watts, instead of being called watts, are called volt-amperes, since they are the product of the volts and amperes. When large values are dealt in, a unit called the kilovolt-ampere is used, just as the kilowatt is used when the watts in a circuit reach a large value. There are 1000 watts in one kilowatt, and similarly there are 1000 volt-amperes in one kilovolt-ampere. The abbreviation for kilovolt-amperes is kv.-a., just as kw. is the abbreviation for kilowatts. The power factor is then equal to kilowatts divided by kilovolt-amperes; that is $P.F. = \frac{kw.}{kv.\text{-}a.}$

When there is no reactance in a circuit, but only resistance, the total alternating-current voltage is effective in causing a current to flow through the circuit. Thus in Fig. 3, where there is resistance only in the circuit, the current flows according to Ohm's law, and will be $I = \frac{E}{R} = \frac{225}{5} = 45$ amperes, as shown. The *true watts* $= I^2R = 45 \times 45 \times 5 = 10{,}125$ watts, and the *apparent watts* $= EI = 225 \times 45 = 10{,}125$ volt-amperes. *Power factor* $=$ *true watts* $\div$ *apparent watts* $= 10{,}125 \div 10{,}125 = 1$. Hence, when there is no reactance in the circuit, the power factor is 1 (or unity as it is called) and the watts are equal to the volt-amperes; but when there is reactance in the circuit, the power

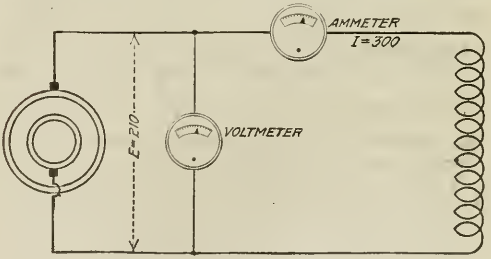


FIG. 2. VOLTMETER AND AMMETER CONNECTED IN A SINGLE-PHASE CIRCUIT

factor is always less than one and the watts are less than the volt-amperes.

Usually, a wattmeter is connected into the circuit as in Fig. 4, in order to measure the actual power. In that event the power factor is most readily ascertained by dividing the wattmeter reading by the product of the voltmeter reading times the ammeter reading. Thus in Fig. 4 the value of W as read on the wattmeter is assumed to be 45,000 watts, the value of E as read on the voltmeter 210 volts, and the value of I as read on the ammeter 300 amperes. Consequently, we have $P.F. = \frac{W}{EI} = \frac{45{,}000}{210 \times 300} = 0.714$, as obtained previously in this discussion.

In an alternating-current circuit it is necessary to have an ammeter connected in the circuit whenever a wattmeter is used to indicate how much current is flowing through the wattmeter. The reading of the wattmeter itself is no indication of what current is flowing through it. If the inductance of the circuit is large in comparison with the resistance, the power factor will be low and the power transmitted in the system will be very small, and consequently the wattmeter will record only a small reading, whereas the current may be very large.

The current flowing in a single-phase circuit is equal to the wattmeter reading divided by the voltmeter reading times the power factor; in other words $I = \frac{W}{E \times P.F.}$

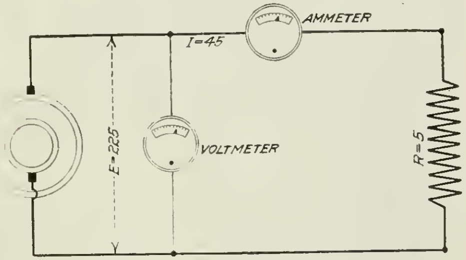


FIG. 3. REPRESENTING ALTERNATING-CURRENT CIRCUIT HAVING RESISTANCE ONLY

Now, if the wattmeter indicates a load of 45,000 watts when the power factor is 0.90 and the voltage 200, the current in the circuit would be $I = \frac{W}{E \times P.F.} = \frac{45{,}000}{200 \times 0.90} = 250$ amperes; if the power factor of the circuit is only 0.50 with the wattmeter reading 45,000 and the voltmeter reading 200, as before, then $I = \frac{45{,}000}{200 \times 0.50} = 450$ amperes. From the foregoing it is evident that the wattmeter reading and voltmeter reading are no indication of the current flowing in an alternating-current circuit, unless the power factor is unity. When the power factor is unity, the current is equal to the watts divided by volts, as in a direct-current circuit.

In Fig. 1, if we divide AC by AB we have $\frac{E}{E_R} = \frac{150}{210} = 0.714$ as a result. It will be noticed that this is the same value as was obtained for the power factor. It will also be noticed that $\frac{AC}{AB}$ is the cosine of the angle θ. Hence we find that the power factor and cosine have the same value. We therefore arrive at the conclusion that the power factor of a system is equal to the cosine of the angle that the total voltage makes with the voltage necessary to cause the current to flow through the resistance of the circuit. If we refer to a table of sines and cosines, as given in the lesson in the July 22 issue of *Power*, we find that cosine 0.714 corresponds to an angle of approximately 44.5 deg. The angle formed between the resistance component of the voltage E_R and the total volts E is also the phase angle between the current and the voltage—in this case the angle of lag. This is the value indicated on a power-factor meter, and the power factor is frequently referred to as the cosine of the phase angle between the current and the voltage. Then to find the angle by which the current is out of step with the voltage, all that is necessary is to take the reading of the power-factor meter and refer to a table of sines and cosines and find the angle whose cosine corresponds to the power-factor meter's indication. Or we may take the voltmeter reading, ammeter reading and wattmeter reading as explained in the foregoing and calculate the power factor, and from this find the phase angle between the current and voltage. Thus, in the problem under consideration the angle of lag between the current and the voltage is 44.5, and since this is due to the inductance of the circuit, the current curve would be shown 44.5 deg. lagging from the voltage curve as in Fig. 5.

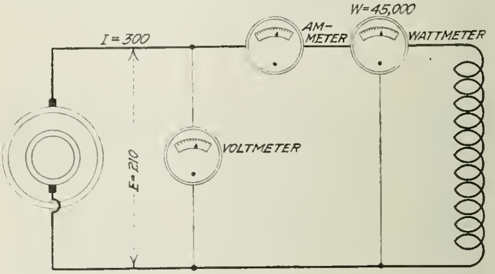


FIG. 4. VOLTMETER, AMMETER AND WATTMETER CONNECTED IN A SINGLE-PHASE CIRCUIT

In a single-phase circuit the voltmeter reads 230, the ammeter 175 and the wattmeter 35 kw.; determine the volt-amperes, kilovolt-amperes, power factor and the phase angle between the current and the voltage.

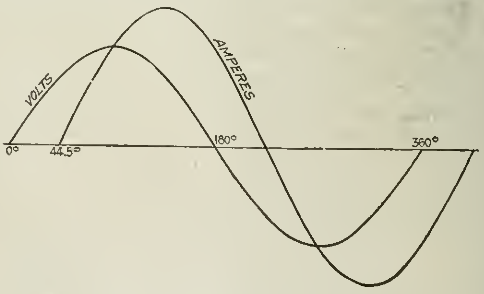


FIG. 5. CURRENT LAGGING THE VOLTS 44.5 DEGREES

The power factor of a single-phase circuit is 0.80. The wattmeter reads 75 kw. when the voltage is 440. Find the ammeter reading, the volt-amperes, kilovolt-amperes and the phase angle between the voltage and current.

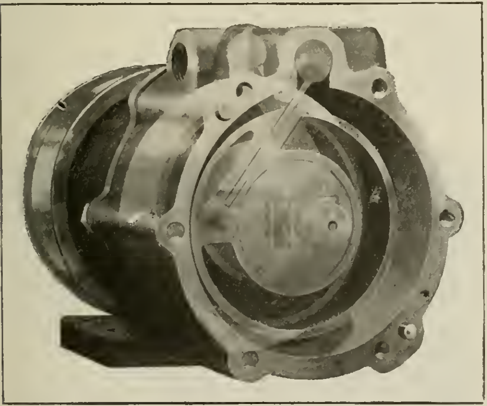
The Rollway Pump

The accompanying illustration shows the construction of the new "Rollway" pump, manufactured by the Michigan Machine Co., Detroit, Mich. The working parts consist of two rollers which rotate eccentrically in the pump chamber.

The pump chamber and rollers form a circle. The pump is divided in two by a steel disk. One roller operates on either side of the disk. The pump shaft is square. The opening in the rollers that fit the shaft is rectangular. A spring is inserted in one end of this rectangle between the square shaft and the roller. The rectangle is so placed on the shaft that it is slightly off center, bringing one side of the roller within a fraction of an inch of contacting with the side of the pump chamber. This contact continues except at a different point as the roller revolves. The rollers are so located on the shaft that they work opposite to each other; that is, when one is on one side of the chamber the other is at the other side.

A rocker that extends from the top of the pump down into the roller cuts off the flow from the discharge side of the pump so that the liquid cannot flow out through the intake. After the contacting point of the roller passes the intake of the pump, it creates a suction gradually filling up the chamber in back of the roller. When this point again reaches the top of the chamber, the liquid that it has taken in on the previous revolution passes out through the discharge while more is coming in at the intake side and so on. Operating alternately produces a steady flow without any pulsations.

The spring which operates between the roller and the shaft is an automatic relief and also prevents the pump from clogging. Should a chip stick in the pump chamber, the spring will compress and allow the roller to pass over it, and it will be washed out at the next revolution. It also operates when the stop-cock is shut.



PHANTOM VIEW OF PUMP SHOWING ROTOR AND SPRING COVER REMOVED

Standard pumps are furnished with controlling spring to develop 25 lb. at 200 r.p.m. and 40 lb. pressure at 420 r.p.m., etc. Pumps can also be furnished with springs to develop either higher or lower pressures, or without springs where very high pressures are required.

This pump may be operated at speeds ranging from 100 to 600 r.p.m., upside-down or right-side-up, and at any point on a machine where its application is most convenient. Either side of the pump may be used for intake or outlet. Where it is necessary to maintain a constant flow in a given direction regardless of the rotation of the pulley, a pump equipped with reverse valves is furnished.

Handling Fires in Stored Coal

By H. A. Ward

In the spring and summer of 1918 we stored 4000 tons of West Virginia nut and slack coal in an area about 140 ft. by 75 ft. This made a pile from 15 ft. to 20 ft. high. We endeavored to keep track of the temperature by occasionally going over the pile with ⅜-in. round rods sharpened at one end. By thrusting the rods down into the pile and allowing them to remain a minute or two and then withdrawing them we could tell by feeling the rods if the coal was heating and just how far the warmest spot was from the surface.

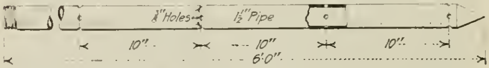


FIG. 1. THERMOMETER PIPE TO SINK IN COAL PILE

F=FIRE H=HOT W=WARM C=COOL

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A	C	C	C	C	C	C	C	C	C	C	C	C	C	C
B	C	C	H	F	H	W	C	C	C	W	W	W	C	C
C	C	W	F	F	H	W	C	C	C	C	W	C	C	C
D	C	C	F	F	W	C	C	C	C	C	C	C	C	C
E	C	C	C	C	W	W	W	C	C	W	W	C	C	C
F	C	C	W	W	C	C	C	C	C	W	W	C	C	C
G	C	C	C	C	C	C	C	C	C	C	C	C	C	C

FIG. 2. TEMPERATURE-LOCATION CHART

When we found a place which seemed to be getting too warm for safety, we would put down a 1-in. pipe and let a thermometer down into it so that we could determine if the temperature was still going up. The 1-in. pipe was prepared as follows: About 15 in. of one end was heated and flattened, thus closing the end. This flat portion was then given a twist like a drill or bit. By inserting this end into the coal and turning the pipe, at the same time exerting downward pressure, the pipe was easily driven through the pile.

Most of the coal was under a shed and in one small area it reached the roof of the shed. This interfered with the use of the ⅜-in. rod, and evidently this part of the pile was not carefully surveyed, as a fire developed about 15 ft. below the surface. To make sure that every part of the pile would be surveyed we put down 1-in. pipe as previously described, every ten feet.

We prepared ten pieces of sash chain the length of the pipes, placing rings in one end of each chain to prevent their being lost in the pipes. The ten chains were then let down into the pipes. By the time the

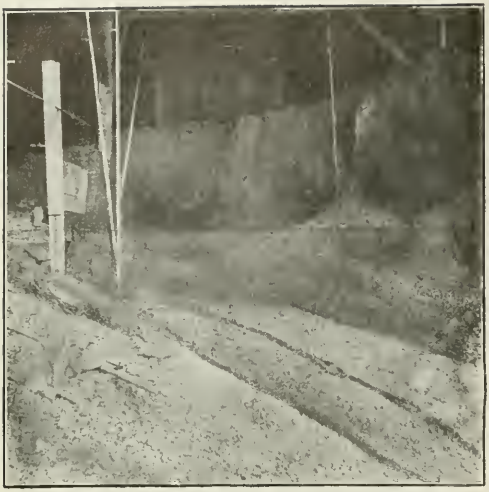


FIG. 3. PART OF PILE LEFT AFTER JUNE 1

last chain was placed, the first chain would become approximately the same temperature as the pipe. By letting the chain pass through the hand as it was withdrawn it was easy to tell the approximate temperature of the station. It was also easy to tell the relative temperature at the various depths at the station. The stations varied in temperature from cool to red hot. In a case of a warm station not in the fire area we usually found that the bottom of the pile was cold, and that the temperature increased, to a point about 8 to 6 ft. from the surface, where it was maximum. From this maximum point the temperature fell as the surface was approached. Every second or third day the entire pile was surveyed, using a cross-section sheet as in Fig. 2.

For a week previous to the starting of the fire the weather had been very hot. We found several stations remote from the fire heating to a dangerous point. As all available labor was employed in digging out the original fire, I decided to try water on the hot stations. Two pieces of 1½-in. pipe each 6 ft. long were prepared as follows: One end of one of the pieces was closed by drawing it to a sharp point. In circles starting at this closed point and spaced 10 in. centers I drilled four ⅜-in. holes 90 deg. apart. These perforations extended the length of the one piece of pipe. The second piece of pipe was fitted to couple to the first and to the fire hose. Then we sunk the perforated section into the coal at a hot station, coupled the second section to it and sunk them to the predetermined depth. After the water had been on 30 min. the pipe was moved to another point in the warm area, and so on until the area had been covered. This treatment brought the temperature down immediately. In some cases one application proved sufficient. In other cases the treatment had to be repeated from time to time. We still have on hand the part of the pile, Fig. 3, which was the most persistent in heating, and it has not had an application of water since the middle of November.

The surveys soon demonstrated that the fire was spreading faster than our force could follow it, and that it must be headed off or the entire pile would be affected. By carefully checking between the pipe stations which seemed to be just outside the affected area to see that the fire had not extended a finger in between, I established a line just outside the affected area. The pointed ⅜-in. rods were used for checking between stations. On 6-ft. centers along this line we put down 1-in. pipe prepared as already described, but with the addition of ⅛-in. holes on circles 18-in. centers. This line of perforated pipes was connected with a common water supply pipe, the water kept on continually. The perforations above the surface of the coal were stopped with wooden plugs. This held the fire within the affected area. With this barrier established we sunk perforated 1-in. pipe into the heaviest of the fire and occasionally turned water into them. This checked the fire but did not put it out. It also did away with much of the smoke and gas which interfered with the digging out of the fire. Although the fire area extended over a space 50 by 40 ft., the fuel loss was comparatively slight. The coked areas were thin and only at the point where the fire originated did we find any indication of ashes.

Nearly all the literature I have found on the subject of heating and firing of stored coal has advised that as soon as the temperature of a station reaches 150 deg. F. the hot spot should be dug out. This is not always practical, as too many hot places may develop at the same time. Many of the articles advise that water seems to aggravate the trouble. I am inclined to believe that if a small quantity of water is used this may be true. The water leaving the hot coal flows through or under other parts of the pile not affected and thereby furnishes the initial heat to spread the trouble.

If a relatively large quantity of water is used, as in the case cited, the temperature of the water flowing through the coal approaches normal. For the same reason I believe that if water is used on the fire it should be in sufficient quantity, or the area treated should be sufficiently small to insure that the water flowing away through the pile should be of comparatively low temperature.

FIG. 4. ANOTHER VIEW OF THE PILE

EDITORIALS

Labor troubles have long delayed this issue of Power, but here it is. Moreover, no issues will be skipped and readers will receive all they subscribe for. We wish to thank our many friends for their support and patience during the suspension of publication.

America Is Yours Do Not Misuse It

THIS game of rising cost of living and upward, upward wages is like carrying water in a pail which leaks so badly that all the water is gone by the time you have reached the place where you want it. You may get a larger pail in the shape of more wages, but the resultant higher cost of things punches a larger hole in it.

The forms of the institutions of man forever change. Man, fundamentally, does not. The same instincts, emotions, and intellectual aspirations which actuated the Pharoahs and slaves of most ancient Egypt actuate the rich America.

Human nature is as enduring as the Rocky Mountains, more steadfast than a valley. It is simple in its make-up, complex in its reactions.

Self-preservation is its first law and the one to which all others are subordinate. A cockroach will fight if cornered.

All men are equal only in the sense that they are moved by the same basic instincts. Even these are not each equally possessed by all men, to say nothing of there being any equality of intellect, ambition, ingenuity, skill, ability in any direction. Men are as far from universal equality in these as their fingerprints are from being alike.

There is equality only before God.

Two of the great primary pursuits of man's life are food and shelter. He fights for these with weapons and laws.

Food and shelter are the reasons for agriculture and industry, whether the grinding of corn Indian fashion or in the Pillsbury mills.

Capital is an aggregation of economic goods used to produce other goods. It is human effort materialized. It is at one and the same time the product of effort and the tool of production.

The efforts that produce capital and make capital produce are manual, scientific and commercial. They are the tripod upon which modern industrial civilization rests. They are civilization's trinity, inseparable.

Regardless of who owns raw materials and capital or who controls labor, the necessities of life are not had unless both are at work to produce and distribute them.

Today the shelves of the world are bare. To replace what the war took from them everybody must work, not less but more.

If the reward (profit) of carrying on a business is too nearly all eaten up in taxes, wages and production costs, it isn't worth a man's while to continue it.

It would be silly to mention the foregoing simple facts if it were not that too much of the world seems to have forgotten them and to be running counter to them. Too many in the realms of both capital and labor seem to be trying to make a living, and more, by the methods of buccaneers.

The people are the consumers who pay all bills, who pay the costs and losses and who pay the ransoms. The railroads are an illuminating example. It won't do.

The people won't go on robbing themselves once they know it. They know it now. The railroad brotherhoods have flatly stated that further increases in wages are futile. It's the cost of living which must come down. It cannot come down if wages generally go up. It cannot come down if profits go up. It won't come down by strikes which curtail production and increase the shortage of the necessities of life. It will not be assisted downward if the intelligensia, the doctors, farmers, clerks, writers, editors, salesmen and other intermediate millions, maddened by the ever-increasing wage of labor, organize, demand and strike. Even now they are on the way. Organized labor has showed them how.

The way out is not by exploiting the United States of America.

When a minority of organized labor tries to do it, it is bolshevism pure and simple. The bolshevism of Lenine came by a coup by which 250,000 industrial workers seized absolute, autocratic control of 180,000,000 people. As conducted, it is the bloodiest, most despotic chapter in human history. It out-czars the Czar a thousand times.

The goal of all the urest today is a juster share in the returns of business by labor. The pendulum is swinging to the extreme, which is not surprising. But the business men and the working men of America can and will effect an adjustment without the bloody instrument of bolshevism. The man is shortsighted who does not see that this is so, whether he be a flaming radical or a stagnant, conservative capitalist.

For the sake of our stomachs, for the sake of the land which is ours, which we love, and which we saved from a despot's heel, let us go to work! Let us produce, produce! We must again show that democracy is safe for the world. America is yours. You cannot afford to misuse it.

State and City Elevator Laws

ONE of the problems confronting operating engineers is the keeping of the equipment in his charge in condition that will meet the various safety laws and regulations in operation in the different states. One of these codes, which is becoming of more importance each year, is the law regulating the construction and operation of elevators. Many of the large cities and a number of states have formulated and put in effect such laws. At the present time there is being prepared a national elevator code by the American Society of Mechanical Engineers working in conjunction with other interested bodies, including the United States

Bureau of Standards. When this code has been completed, there is every reason to believe that it will give impetus to the putting in force some form of elevator code in almost every state and large city.

To place before its readers some of the important elevator regulations of both states and cities, *Power* is going to publish excerpts from these laws. The first of these appears on page ??? in this issue and cover the regulations for New York State and City. Although the excerpts do not embrace the laws in all their different phases, especially as to new construction, they are complete enough in regard to existing installation to show those that are responsible for the upkeep and safety of elevator equipment if the regulations are being complied with and, if not, what must be done to meet the code.

Elevators in large cities have become of equal importance with electrical railway systems of transportation for handling the general public and employees of large industries. Therefore equal precaution should be taken in their operation. The reduction in the number of fatal accidents due to elevators where proper regulations are enforced is the one best argument for their promulgation. In the State of Pennsylvania in 1918 there were no fatal accidents from the operation of elevators, which cannot be said of states that have no elevator codes or of states that have regulation but are less exacting than the Pennsylvania code, which is accredited with being one of the best elevator laws in this country.

A large percentage of elevator accidents are caused either directly or indirectly from the use of shaft gates and doors that can be opened from the outside, or gates that are so low as to allow employees or others standing on the landings to look over into the shaft. The remedy in the former case is electric contacts on the doors and gates so that the cars cannot be started when the doors or gates are open, and in the latter case gates of sufficient height so that anyone standing on the landing cannot look over into the shaft. Regulations requiring proper shaft doors, car enclosures, next to proper safeties, will do more toward preventing accidents than any other requirement. Such installations are not expensive, especially on elevators that are electrically driven, and this type of machine forms a very large percentage of all those in use, consequently there is small reason why such requirement should not be part of all elevator codes. Where such a law is enforced, it has practically eliminated all fatal elevator accidents. Aside from the humanitarian and safety side, the prevention of one accident may many times pay for the installation of the necessary device to make the accident impossible.

Power-Plant Operating Record

The combination of the loose-leaf ledger form for log sheets and other statistics, reinforced by the card-index system of graphic records, is a scheme of power-plant bookkeeping that is coming more generally into use as its advantages become better known. All the records taken in the plant have a timely value and a few of them have a permanent value, but many of them after a year or so have little worth. Any possible value that the records may possess in any case will be only in proportion to the accessibility of their contents.

The records are made for the sole purpose of providing a future reference to the exact conditions existing at some particular time or to the results of routine or experimental accomplishments made under usual or extraordinary operating conditions. When this information is most needed, circumstances usually are such as to allow little time or inclination for searches for either the records or their contents. Printed forms are costly, as is the labor spent on inscribing the entries on them; so that if bunches of individual sheets tied in packages or enormous and awkward logbooks are to be stacked away in dusty storerooms, the investment made on them will be out of proportion to the value received.

Little of the data customarily collected, on switchboard log sheets, etc., is worth preserving. The bulk of the records made periodically over the whole day in the plant become useless after a time. An intelligent summary of them is of far greater value and can be inscribed on considerably less paper.

A summary of the hours idle, in reserve or operating, and the output for the day of each unit—boiler, turbine or generator—together with its load factor, its maximum, minimum and average loads and the details of its operation at those loads—such as its temperature, current, power factor, etc., if a generator; its vacuum, steam flow, condenser-water temperature, etc., if a turbine; its hours steaming, floating, banked and dead, coal consumption, etc., if a boiler—is of far greater value than all the itemized notations made periodically over the entire day. However, the periodic records have a timely value and are essential both as a check on the operation of the plant and as the means of providing the data for the permanent records.

The same thing applies to the group records made for the whole plant. Like summarizations may be made of the consumption of coal, water, oil, and all the lesser details of operation; and all the general information gathered for any one day may be summarized on one sheet. From these daily summaries are then made the weekly, monthly and yearly summaries. All the permanent record sheets may be then bound in attractive yearly or half-yearly volumes and constitute a library for the plant that is imposing as well as indispensable.

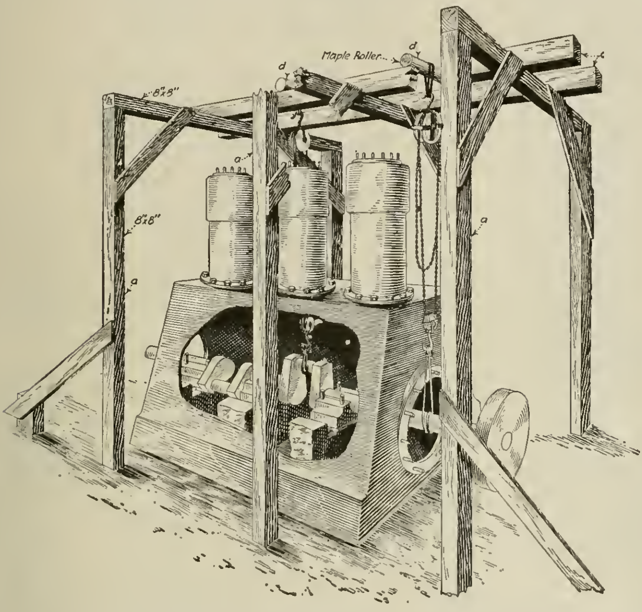
Reinforcing the volumes of written statistics, a card index is maintained. Yearly load curves are kept on the cards showing the weekly peaks of the station and the different classes of service supplied. Coal consumption, various plant costs, engine or turbine efficiency and other records of the plant are thus graphically portrayed on these cards. The cards are ruled in cross-section in a special form, so that one card form is adaptable to all requirements. They range in size from 6 x 8 in., to the standard letter size, according to the method used in filing them.

The trend toward efficiency of operation has been to isolate that information possessing only a timely worth and to conveniently assemble and preserve that found to be of permanent value. The old style daily load curve has lost much of its value. Logbooks are no longer the massive, awkward volumes of old, containing great sheets of figures over which were inscribed various colored curves representative of different phases of operation.

Correspondence

Removal of Diesel Crankshaft

Recently, it became necessary to remove the crankshaft of a three-cylinder vertical Diesel engine. This unit was provided with a box frame with circular flanges at each end, surrounding the shaft. The shaft had to be raised off the main bearings and moved longitudinally through the circular flange opening. Considering the diameter of the opening, which was 30 in., in relation to the extreme width of the crankshaft from pin to pin, 30½ in., the task was by no means an easy one. The job was made increasingly difficult by the inability to remove the bearing-cap studs. Furthermore, the engine had been moved outside the engine room, so that there was no trolley chain hoist to do the work. A frame of 8 x 8-in. oak timbers was erected, as shown in Fig. 1. At the tops of the vertical timbers *a*, ¾-in. holes were bored to a depth of 10 in. and threaded iron rods inserted. The three top cross-timbers *b* were bored and held fast by the bolts in *a*. Two 16-ft., 8 x 8-in. timbers *c* were spiked longitudinally on the cross-timbers.



FRAMEWORK AND POSITION OF THE BLOCKS USED FOR THE REMOVAL OF CRANKSHAFT

Two 6-in. maple rollers *d* were placed on the timbers *c*, and rope slings were passed around them and fastened to two 4-ton chain blocks. Since the shaft weighed eight tons, the blocks were amply strong.

The main-bearing caps were removed from all the bearings, while the entire end bearing was taken out in order to provide room for the removal of the crankshaft. The bearing wedges were not touched, and as the bearing was dowel-pinned against side shifting, the bearing could be replaced without realigning the shaft.

Rope slings were passed around the shaft and hooked to the blocks. The shaft was then lifted. Two workmen, using small bars, pinched the rollers along the timbers *c* until the block chains touched the sides of the top openings of the engine frame. The shaft was then blocked up and the rollers moved to a new position, whereupon the blocks were again fastened to the shaft and the endwise movement of the shaft continued.

The three sets of crankpin throws were of course 120 deg. apart, and this necessitated continual shifting of the shaft to allow the throws to pass the main-bearing studbolts.

At the beginning of the work various estimates as to the time required were secured from practical engineers. These estimates ran from four days to ten days with an expected cost ranging from $200 to $400. The actual time was surprisingly low. Six men were used for 15 hours in removing the frame doors and bearings and in erecting the framework. The time occupied in actually handling the shaft was just 5 hours. The cost was as follows:

Labor:	
Removal of doors and erection of frame (90 hours)...............	$45.00
Removal of crankshafts (30 hours)	15.00
Lumber:	
Seven 8 x 8-in. oak timbers 16 ft. long, eight 2 x 6-in. spruce planks 16 ft. long, 750 feet at $70 per M.	52.50
Total........................	$112.50

Since the timber was already on hand, this item is hardly chargeable to the job, and the actual cost was $60 with two or three dollars for spikes and bolts that were not charged.

E. E. SNOW.

San Pedro, Republica Dominicana.

Homemade Asbestos Gaskest

A cheap method of making a tight flange joint and one that will stay tight, is to use wet sheet asbestos $\frac{1}{16}$-in. thick. This can be used only when the flange is lying flat and the other half can be carefully lowered upon it, as wet sheet asbestos becomes so soft that it cannot be handled. The gasket must be cut to the proper size, then laid on the face of the flange and water applied. Joints made in this way 15 years ago are still tight.

One engineer made a gasket from the $\frac{1}{16}$-in. sheet asbestos with a covering of fine brass gauze on each side. This gasket could be made wet and used on joints in any position. Every joint made with such a gasket was a success.

JAMES ELLETHORN.

Kingston, Ont., Can.

Synchronizing Two Alternators When Driven by One Turbine

We have two 50-kv.-a. 220-volt three-phase 60-cycle generators, both direct-connected to one steam turbine through reducing gears. The shaft in the turbine became worn, and the engineer took it out and put in a new one. In doing so he must have shifted the gears so that when the couplings were bolted together the rotors were in some way displaced from their original position.

When the turbine was started and the fields excited, the generators' stator windings would get so hot in a few minutes that they had to be shut down. The generators were phased out and leads that were together run a motor in the same direction. I shifted the coupling of one generator one bolt hole and got the field magnets in the same position on both generators, which did away with the heating when the turbine was driving the generators, 1300 r.p.m. and the generators not excited. As soon as the voltage was raised to 220, the turbine slowed down to 1150 r.p.m., and an ammeter connected in one of the leads shows 75 amperes flowing between the generators. Both generators are excited from the same exciter, and the voltages of both are controlled from the same rheostat. A voltmeter shows four volts difference between the generators.

The generators run 1200 r.p.m. and have 6 poles and 72 coils, the latter connected parallel-star. Is there any way of telling how to mesh the gears so that the generators will be in phase at all times?

South Kaukauna, Wis. Marion Phillips.

[This letter was submitted to K. A. Reed, who gives the following explanation.—Editor.]

In all probabilities Mr. Phillips has a unit composed of a high-speed turbine direct-connected to two alternating-current generators by means of a single pinion and two gears, as illustrated in Fig. 1. Assuming that this is true, the trouble experienced is due to the fact that when the engineer dismantled the unit, he failed to mark the pinion and gears, and when it was reassembled they had to be meshed by guess. The result is that the field poles have been moved from their original relative position and the machines are mechanically out of phase; consequently, there is a large circulating current between them at no load when they are connected in parallel and brought up to voltage.

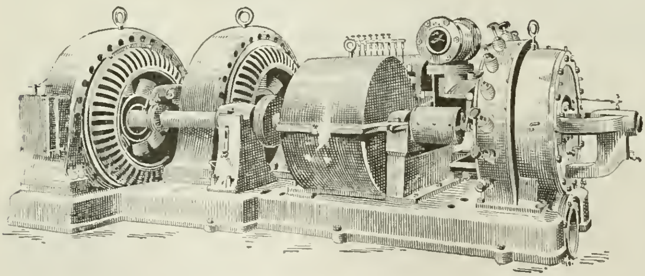


FIG. 1. TURBINE GEARED TO TWO ALTERNATORS

Shifting the field of one generator the space between coupling bolts is taking too large a step, since it moves the field poles of this machine one-quarter of a revolution forward or backward, when the generators are probably only a few slots out of phase. The reason for the speed dropping from 1300 r.p.m. with no excitation to 1150 r.p.m. at normal voltage of the machines is probably due to the load of 75 amperes which comes on as the voltage is brought up, and the turbine governor possibly needs some attention. In order to get proper operation out of this unit, it will be necessary to place the generators in exact synchronism mechanically, and this may be done in the following manner:

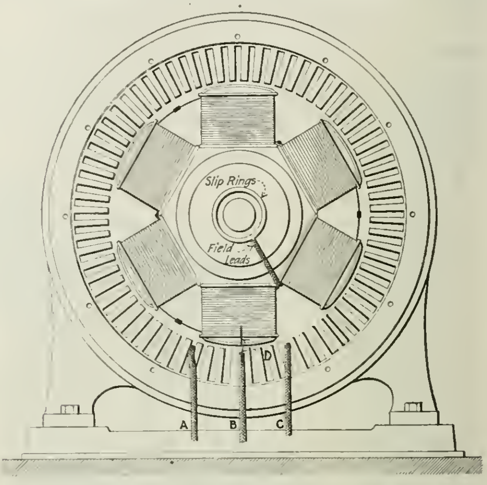


FIG. 2. DIAGRAM SHOWING RELATION BETWEEN POLE-PIECES AND PHASE LEADS

Turn the fields of the generators by hand until the center of the field coil connected to one of the collector rings, say the inside ring, of the left-hand machine comes exactly over a phase-coil lead slot, say phase *B*, as in Fig. 2. Now loosen the bearings of the right-hand machine and unmesh its gear from the turbine pinion. Turn the field of this machine without disturbing the position of the other machine until the field connected to its inside collector ring and the lead coil of phase *B* are in the same relative position as on the left-hand machine. Then mesh the gears and tighten up the bearings. In order to be able to again place the fields in the exact positions which they are now relative to the stator-phase coils, the position of the field poles over the phase *B* leads and the slots from which the leads come out should be marked with chalk, as at *D*, Fig. 2. The machines will now be synchronized as nearly as possible by guess. It may be found necessary, however, to reverse the leads from the exciter to the collector rings of one of the machines.

Bring the unit up to speed with the resistance in both exciter and generator field rheostats all turned in. With an ammeter in one of the generator leads close the switch that connects the machines in parallel and bring up their voltages. Observe the current indicated by the ammeter, and if it is abnormally high (over 100 amperes), shut down the unit and reverse the field leads to one pair of collector rings, as mentioned in the foregoing. The circulating current should now be very much reduced or practically eliminated. However, if an appreciable current still flows, the fields should be placed in exactly the same position as before by means of the chalk marks, and the right-hand gear unmeshed. Rotate this field about two slots either forward or backward, using the chalk mark as an indicator, for trial; remesh the gears and try again. If the current between the machines is less than before, it is obvious that the field was shifted in the correct direction, and it is only a question of shifting this field one or two slots at a time until the generators are properly synchronized mechanically. If the current is greater than before, the shifting was in the wrong direction and must be reversed.

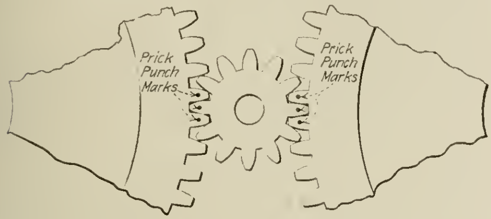


FIG. 3. HOW GEARS ARE MARKED AFTER BEING PROPERLY MESHED

After the proper meshing of the gears has been secured, the pinion and the gears should be center-punched as in Fig. 3, in order that the machine can be reassembled properly if dismantled at a later date. Somewhat better operation will be secured and the current between machines will be reduced by inserting the proper amount of permanent resistance in the field circuit of the generator whose voltage is four volts high to make its voltage the same as that of the other machine.

In answer to the last question in Mr. Phillips' letter, it should be noted that after the gears are properly meshed and the field leads connected to the collector rings correctly, the generators will be in phase at all times. K. A. Reed.

New York City.

Priming Centrifugal Pumps

Two reciprocating pumps originally supplied all the water required for house-service use and makeup in a plant at which I was employed, but upon enlarging the works two turbine-driven double-suction centrifugal pumps were installed. The centrifugal pumps are on a single suction line with a suction lift of 10 ft., working against a pressure in the house-service line of 60 lb., and each was rated at 350 gal. per min. The suction line for the pumps had a twin-strainer and float-valve fittings.

The pumps were primed by filling the casing and suction lines with water, supplied from the house service line, which was kept under pressure, and bleeding the air through a pet-cock on top of the casing.

This method sufficed until the foot valve became inoperative and would not hold water, and considerable trouble was experienced in picking up water when only the pump casing and short length of pipe to the strainer could be filled. It was thought that rubbish was caught in the valve and prevented it from seating properly and that in time it would clear itself. Therefore no inspection of the valve was made, owing to its arrangement in the intake tunnel and the delay and expense involved, but the valve did not clear itself. Having two surface condensers, one or the other of which was always in operation, we ran a 1-in. line from the pumps to each condenser, and now our priming troubles have practically disappeared.

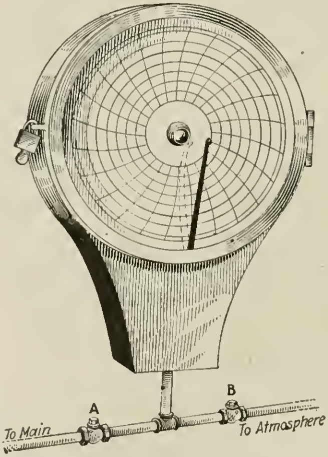
The water for seating the pump shafts in the stuffing-boxes was originally taken from the discharge side of the pump, below the check-valve, which means that when priming with the vacuum line no sealing water on this pump was available, so a connection was made above the check valve on the discharge line, which insures plenty of sealing water.

I might state that if the service-water pressure drops below 40 lb. a tank on the roof will feed into the line, and in case of a pump going out of service this tank will keep up a supply from 10 to 20 minutes, depending on the number of units in the service, etc., thus giving ample time to get another pump in operation.

Chicago, Ill. Arnold Erickson.

Check Valves in Recording Steam-Gage Piping

In looking over the Aug. 12 issue I read I. S. Chamberlain's letter on steam-gage connections. If the check valve at *A* closes to prevent the vacuum in the line from forcing the pen hand too low, how does the pen work with a falling steam pressure? It would seem that an increase in pressure would be recorded more or less truly, but that a lowering of pressure would not permit the gage to record properly. Secondly, a column of water should be in the gage pipe at all times to protect it.



ARRANGEMENT OF CHECK VALVES

If air is drawn in the pipe at *B*, will not this cushion affect the working of the gage?

New York City. C. W. Peters.

Why Does the Water Lift in a Boiler When the Safety Valve Blows?

In response to your editorial request in the issue of June 24, I submit the following:

If steam is being formed in a body of water more rapidly than it can separate from the water, then the volume of the water must expand by reason of the contained steam.

A well-built boiler is designed so that the maximum quantity of steam capable of being produced on its heating surfaces can be liberated from the water without undue ebullition. In such a boiler no severity of firing can cause the water to lift, but when the water is called upon to liberate, not only the steam coming from the heating surfaces, but also the large quantity of steam—of stored—energy that comes from the whole body of the water on a reduction of pressure, it can easily be seen why the water may lift when a safety valve blows. If the heating surfaces are not working hard and the quantity of water in the boiler at the time is not great, there is very little danger of its lifting. Some of us think that lifting occurs when the glass is full because the water level is close to the safety-valve nozzle. This is only part of the truth; the rest of it is that the larger body of water contains a great quantity of steam to be liberated for a given drop in pressure, bringing about the conditions of the opening statement.

Add to this the fact that the rising water is thrown to the center of the boiler by the arc of the shell or drum above the water level, thus causing it to creep up the curved shell to the safety-valve nozzle. From this it seems plain that the thing to be avoided is a too rapid lowering of pressure, making the capacity of the valve the important point rather than whether it be of large disk and low lift or small disk with high lift.

The best solution I know of is the use of two small valves rather than one big one. These are mounted on the branches of a common yoke and are set to pop about one pound apart. The lower set one will blow with a small capacity and a correspondingly slow reduction of pressure for all ordinary relief, and the higher set one operates only in case of emergency. This gives a rapid reduction in pressure through the operation of the combined valves only when such rapid reduction is needed.

Here in British Columbia it is against the law to put on a valve larger than 3 in., and where greater capacity is needed two valves are specified.

Vancouver, B. C., Canada. R. Manly Orr.

I read with much interest the editorial on page 983 of the June 24 issue, "Why Does the Water in a Boiler Lift When the Safety Valve Blows?" It is true that though we cannot physically visualize the actual happenings in a closed vessel such as a boiler when the safety valve blows, we can try and mentally do so, and reason thereon in logical steps and thereby reach a conclusion as to what really does take place.

To my mind, the diminution of pressure immediately below the valve opening, coupled with the physical action of the steam as it rushes to the point of discharge, is responsible for the carrying over of the water in the following manner: The diminution of the pressure takes place almost instantly over a certain portion of the cubical contents of the boiler. This area of reduced pressure reaches to and below the water line of the boiler, and because of that reduced pressure the volume of water thus affected immediately flashes into steam (necessarily of a very wet nature because there is a great amount of entrained water in it). The action of the increased amount of water flashing into steam leaves more or less of a hollow in the general water level, and the water then remaining in the boiler sets up another counter-current in its endeavor to overcome the unstable condition thus caused, and the resultant effect is somewhat of a wave-crest action, which heads immediately under the valve opening, thus raising the water level at this point somewhat higher than the other general water level in the boiler. In the meantime, however, the rush of steam toward the valve opening has become more or less of a swirl (as the water running out of any container will tend to do if the flow of water is from all sides toward the point of discharge), and the physical action of the steam, rushing in this swirling manner around and upward immediately over the wave crest, takes up a certain amount of water; which water is half water and half steam, the ebullition having become so great at this point from the reduced pressure, and carries it over or out of the valve. When this slug of water entrained in the steam strikes the constricted area of the valve opening, there is more or less of a damming up of the steam and therefore a reaction, or reverse pressure wave, that carries back to the water level and causes, first, a greater depression of the water level, which in turn causes a recurrence of the wave or cresting effect, and the continued flow of steam carries over more and more of the water until finally it appears almost as if it were a solid stream of water.

The wave action is somewhat similar to that which can be produced in an open vessel by the rythmic action of a paddle working perpendicularly to the surface of the water. I have seen this wave action so great that it would cause the water to rise as high as 12 in. above the normal water level where there had been very little effort exerted, and had there been the scouring and carrying effect of a heavy current of air or steam, there is little doubt that the vessel would have been entirely emptied, though I do not believe that the carrying over of water from a blowing safety valve could empty a boiler. McKean Maffitt.

Wilmington, N. C.

Regarding lifting water when the safety valve blows, why not connect the safety valve to a dry pipe extended along the inside of the boiler, close to the plates, and draw steam from the entire length of the boiler when the safety valve opens, instead of from one point directly under the valve, as is usually the case.

Another condition that will help in preventing the water lifting is to keep the water level at or slightly below the column second gage-cock. Some water tenders keep the water level up to the top try-cock, or within two or three inches in the top of the gage-glass, although they know that the area of the surface of the water inside the boiler is thereby reduced, and they *should* know that the greater the area of the water surface the easier a large volume of steam will be given off, thus reducing the chance of priming or lifting of the water. James E. Noble.

Kingston, Ont., Canada.

Inquiries of General Interest

Cutting Pipe Threads on a Lathe—When cutting pipe threads on a lathe with taper attachment, should the lathe tool be set square with the taper or square with the lathe center? F. A. K.

The cutting tool carried by the taper attachment should be set square with the lathe center; that is to say, the tool is ground to cut a V-thread of 60 deg. and so set that each side of the finished thread will make an angle of 60 deg. with the lathe center, or what would be the same thing, 30 deg. each side of a line square with the lathe center.

Moisture in Transformer Oil—What is a simple method of testing transformer oil for moisture? W. E. S.

Anhydrous copper sulphate when placed in transformer oil will give a bluish tint if moisture is present in the oil. If some small pieces of hot iron or nails are dropped into a sample of the oil the presence of moisture will be indicated by the hissing sound produced. Before applying either one of these tests by the uninitiated, it will be advisable to make the tests on samples that are known to contain moisture and others that are known to be "dry," so as to become familiar with the reactions under both conditions.

Front of Engine—What is the front of a horizontal engine? A. C. U.

The front is the face or part opposite to the cylinder end of the engine. The cylinder end is commonly called the "back" end. These terms are not self-explanatory, and "cylinder end" and "crank end" are better. The only excuse for "front" and "back" end would appear to be that they are consistent with calling the stroke of piston from the outboard end of the cylinder the "forward" stroke, in agreement with the usual direction of the power stroke of a single-acting engine, and for the stroke to be "forward" it would have to be toward the "front."

Effects of Low Power Factor—Will an alternating-current generator be affected by poor power factor, when the generator is supplying power directly to lightly loaded induction motors, the same as when the load is supplied through transformers? E. G. H.

It will not make any difference whether the generator supplies the power directly to the motors or through transformers to the motors, the kilowatt capacity of the generator will be reduced in either case by the low power factor of the motors. However, the power factor of the system will be lower where the transformers are used, on account of the power factor of the transformer being less than unity even under full load.

Convex and Concave Bumped Heads—How are bumped heads of steel plate named with respect to the manner in which they are set in drums, and what is their relative strength with respect to the side receiving pressure? F. A.

Bumped or dished heads are called convex or concave according to the form of the side that is presented outside of the drum or other vessel in which they are used. In good practice the concave heads of drums or other pressure vessels that have the pressure on the convex side of the heads are allowed a maximum working pressure equal to 60 per cent. of that allowed for dished heads of the same dimensions with the pressure on the concave side.

Right-Hand and Left-Hand Shoveling—Is a right-hand shoveler one who supports the weight with the right hand, or with the left hand? G. A.

A right-hand shoveler supports the weight on the scoop or blade by holding up the tang or the neck of the shovel handle with the left hand. He grasps the handle farther away from the tang, usually at or near the free end of the handle, with the right hand, and the directon of his toss is from his right hand toward his left hand. When the positions of his hands and direction of his toss are the reverse, the method is called left-hand shoveling. Each method is named to accord with the manner that is more natural to a right-handed or to a left-handed person in the exertion of his strength to fill the shovel and perform the toss.

Gain from Heating Feed Water—For generation of steam at 90 lb. gage, what is the percentage gain when boiler-feed water is heated from 50 deg. F. to 210 deg. F.? R. L.

A pound of dry saturated steam at 90 lb. gage, or 105 lb. absolute, contains 1187.0 B.t.u. above 32 deg. F., and when the feed water is at the temperature of 50 deg. F., or (50 − 32) = 18 deg. above 32 deg. F., for conversion into steam at the stated pressure each pound must receive 1187.2 − 18 = 1169.2 B.t.u. When the feed water is at the temperature of 210 deg. F., each pound of feed water evaporated requires 210 − 50 = 160 B.t.u. less, or only (1169.2 − 160) ÷ 1169.2 × 100 = 86.3 per cent. as much heat for conversion into steam, and the gain would be 13.7 per cent.

Synchronous Motor for Power-Factor Correction—When synchronous motors are used for power-factor correction, what horsepower capacity should be used per 100-hp. capacity of induction motors? The sizes of the induction motors range from 10 to 30 hp., and the system has about 200-hp. capacity. E. G. H.

There is no specified number of synchronous-motor horsepower capacity required for power-factor correction per 100 hp. of induction motors installed. The synchronous-motor capacity required will depend upon how much of the mechanical load is to be driven by this motor, the value of the power factor before correction and the amount of the correction. If the induction motors are lightly loaded, the power factor will be low and a greater kilovolt-ampere capacity will be required in the synchronous motor to correct the power factor than where the induction motors are operating near their rated capacity and the power factor is at a comparatively high value.

Physical Properties of Materials—What is meant by the terms "elastic limit," "modulus of elasticity," "permanent set," "ultimate strength," "percentage of elongation" and "reduction of cross-section" with reference to materials of construction? R. N. B.

The elastic limit is a more or less definite value of the unit of stress beyond which, as the stress is increased, there is a greater relative deformation than the increase of stress. "Permanent set" is used to represent the lasting deformations produced by stresses greater than the elastic limit. "Modulus of elasticity" is a term used to express the ratio of the unit stress to the deformation per unit length within the elastic limit. The total stress under which a body fails is called its "ultimate strength." The ratio of the total elongation of the specimen to its original length is called the "percentage of elongation." For calculations of percentages of elongation measurements are usually taken between marks originally 8 inches apart. "Reduction of cross-section" is usually expressed as a ratio of the smallest cross-sectional area after rupture to the original cross-sectional area.

Excerpts from Elevator Laws of New York State and New York City

By EDWARD A. SMITH
Mechanical Engineer, Otis Elevator Co., New York, N. Y.

EXCERPTS from rules of New York State Factory Laws for power-driven passenger, freight, sidewalk and handpower elevators, effective Apr. 25, 1915, in factory buildings only. These rules do not apply to New York City.

Load: Passenger—75 lb. per sq.ft. floor area; Freight—50 lb. per sq.ft. floor area, lowering where more than 100 persons are employed.

Runby at top: Passenger and freight—18 in. minimum, 100 f.p.m. or less, between the top of crosshead and underside of grating; 2 ft. 0 in., over 100 f.p.m. and inc. 150; 2 ft. 6 in., over 150 f.p.m. and inc. 200; 3 ft. 0 in., over 200 f.p.m. and inc. 250; 3 ft. 6 in., over 250 f.p.m. and inc. 300; 4 ft. 0 in., over 300 f.p.m. and inc. 350; 4 ft. 6 in., over 350 f.p.m. and inc. 400; 5 ft. max., over 400 f.p.m. Same for counterweight, except with car on bumpers, 3 ft. maximum runby required. May be modified where long stroke bumpers are used with shaft slow-down.

Pit: Passenger, Freight and Sidewalk—6 in. minimum 50 f.p.m. or less between underside of car sling and pit: 12 in., over 50 f.p.m. and inc. 100 f.p.m.; 18 in., over 100 f.p.m. and inc. 150 f.p.m.; 2 ft. 0 in., over 150 f.p.m. and inc. 200 f.p.m.; 2 ft. 6 in., over 200 f.p.m. and inc. 250 f.p.m.: 3 in. max., over 250 f.p.m.

Guides: Passenger, Freight and Sidewalk—Steel or wood guides permitted.

Safeties and Governor: Passenger and Freight—Safety devices approved by commission under platform with governor to trip at 200 ft. for car speed 150 ft. per min. Greater car speeds of 40 per cent. in excess. No safety required on plunger elevators. Sidewalk, none required for rise of 30 ft. or under.

Car Enclosure Platform: Passenger—Substantial enclosure all sides except entrances. Emergency exit in top of car. Emergency exit may be in side of car, where two or more cars are in same shaft. If grill enclosure is used, 1½ in. spaced 1-in. straight bars. Folding gates not required if distance between car and hatch enclosure or door does not exceed 3 in. Contacts required on gates except one adjacent to operator. Platforms or enclosure not fireproofed. Cars to be lighted. Freight—Substantial enclosure 5 ft. 6 in. high. Slats may be used spaced to prevent hand or foot passing through. Solid over counterweight. Top of car No. 8 wire 1½-in. mesh, not to within 8 in. of hatchway at entrance sides unless car gate is provided. Sections may swing up. Platforms and enclosures are not required to be fireproofed. Car to be lighted.

Control: Passenger, Freight and Sidewalk—Car switch, lever or other controlling device to be located near most-used car opening. Where handrope or other controlling device is outside car, opening in car permitted.

Gates: Passenger and Freight—In new buildings shafts are required to be fireproofed. Gates not permitted, except with self-closing swinging doors. Then they are required. In existing buildings gates permitted in non-fireproof hatch, to be self-closing or manually operated. If manually operated, must have contacts. All gates 5 ft. 6 in. high with 10-in. under-clearance, with 2 in. between bars and to resist 150 lb. at center. Gates more than 12 in. from sill, 3 ft. 6 in. high not permitted for passenger elevators.

Gates: Freight only—Gates more than 12 in. from sill 3 ft. 6 in. high with 10 in. under-clearance if car is provided with telltale chains 4 ft. long, 6 in. apart, 2 in. from front of car. Telltale chains not required if automatic trap doors are used. If above conditions are impractical, commissioner will grant modification. Flexible-type gate permitted. Sidewalk—Same as for freight except there will be no gate at sidewalk level.

Ropes: Passenger and Freight—Not less than two ropes to car and counterweight. One full turn required on drum machines. Passenger safety factor, 8; freight safety factor, 6. No regulation for governor ropes. Sidewalk, ropes or chains permitted. Safety factor, 6.

Bumpers—Passenger and Freight—Springs under car

Grating: Passenger and Freight: Substantial grating to sustain 500 lb. required under overhead sheaves and other spaces not otherwise protected. For large elevators partial grating with hand rail and toe guard accepted. Wooden platforms or reinforced-concrete slabs permitted.

Counterweight Screens: Passenger, Freight and Sidewalk—Bottom screen, 5 ft. high. Bottom of screen, 18 in. above pit. For drum machines only, top screen 8 ft. long below beams. No. 16 gage iron or steel plates or other material of equal strength. In existing elevators if impossible to install screens between car and counterweight, use four telltale chains 4 ft. long on bottom of counterweight. Upper screens not required on traction or plunger elevators.

Stop Motion and Shaft Limits: Passenger, Freight and Sidewalk—Required on machine and in hatchway. No machine limits required on traction machines. Stop balls on handrope or chain will be considered as a hatchway limit.

Interlocks: Passenger—Electric contacts with emergency cutout in car or other device approved by commissioner. Required on swinging doors. Manually operated Peelle doors must have contacts with cutout in car. Electro-mechanical interlocks with emergency cutout in car and releases at floors will be accepted. Freight—Same as passenger. Vertical sliding, manual operated doors require contacts.

Emergency Switches: Passenger and Freight—None required except as noted in interlocks.

Brakes: Passenger, Freight and Sidewalk—No regulation. Electric, mechanical or electro-mechanical permitted.

Rope Locks: Passenger—No regulation. Freight—Required if car has no regular attendant. Sidewalk—No regulation.

Hatchway Enclosure: Passenger—Existing hoistways, enclosure to extend from floor to ceiling on door sides of hatchway. Door openings to have gates or doors to protect opening. On all other sides enclosure 6 ft. high. Enclosure to be walls, windows, screens or partitions. If grill is used, 1½ in. spaced 1 in. straight bars. Where trap doors are used, railing or solid enclosure 3 ft. 6 in. high, 12 in. from hatchway. Underside of sills to be beveled 60 deg. from horizontal. Freight and Sidewalk—Existing hoistways or hoistways reconstructed in old buildings, enclosures not less than 6 ft. on all sides except at openings where gates or doors are to be provided. Underside of sills to be beveled 60 deg. from horizontal. Future installations same as passenger.

Hatchway Doors: Passenger — In future buildings must have fireproof doors (see Labor Law 79—A-6). In existing buildings built prior to Oct. 1, 1913, sliding doors or gates to be full automatic or manually operated or self-closing or equipped with interlocking devices. If manually operated, doors to have key from outside. Peelle doors to have electric contacts. Swinging doors to be manually operated or self-closing. Manually operated doors to be provided with electric contacts and with emergency cutout in car or other approved device. Keys to open doors from outside to be furnished. Freight—In existing buildings built prior to Oct. 1, 1913, vertical or horizontal sliding doors may remain if high and strong enough for particular requirements where they are used. In future buildings same as passenger. Vertical sliding doors shall be self-closing or manually operated. If manually operated, electric contacts required or other device that will insure that doors are closed before car starts. Swinging doors, same as for passenger. Sidewalk—Same as for freight elevators.

Trapdoors: Passenger—Not permitted. Freight—Permitted only in buildings erected prior to Oct. 1, 1913, for open hatchways, with railing and semiautomatic gates 3 ft. 6 in. high placed 12 in. from hatch line. Doors to furnish a substantial floor covering when closed.

Motor-Room Enclosure: Passenger, Freight and Sidewalk—No regulation. Should be furnished in fireproof buildings in accordance with Labor Law 79—A-6 and 79—F-5.

Carriage Hoists: Future four corner pick-up power-driven carriage-type elevators not permitted.

Handpower Elevators: Maximum rise 75 ft. Wood or steel guides, broken-rope spring-operated safeties permitted. Car enclosure 5 ft. 6 in. high (no top required). If hatch way is enclosed floor to ceiling, no car enclosure required. On handpower sidewalk elevator, no car enclosure required Hatch enclosure and semiautomatic gates required.

Operator: Required on all passenger elevators, competent operator 18 years old or over, except for push-button elevators.

Exit Facilities: In future installations no elevator to descend in passageways.

Elevators of New York City

Excerpts from elevator laws of New York City for power-driven passenger, freight and sidewalk elevators, except Department of Docks—(no regulation)—U. S. Government. Effective Aug. 26, 1918. Amended May 13, 1919. Effective June 9, 1919.

Load: Passenger—75 lb. per sq.ft. inside area. Capacity plate with suitable lettering required. Freight and Sidewalk—50 lb. per sq.ft., not exceeding 100 sq.ft. inside area. No regulation above 100 sq.ft. inside area.

Speed: Passenger, Freight and Sidewalk—Shall not exceed 700 ft. per minute.

Current: Passenger, Freight and Sidewalk — Reverse-phase relay required on all future polyphase installations. No other regulation.

Runby at

Top: Passenger and Freight—Not exceeding 100 f.p.m., 2 ft.; not exceeding 350 f.p.m., 3 ft.; above 350 f.p.m., 5 ft.

Pit: Passenger and Freight—Between lowest floor saddle and bottom of pit—not exceeding 250 f.p.m., 4 ft.; not exceeding 400 f.p.m., 5 ft.; above 400 f.p.m., 6 ft. Must be at least 2 ft. between underside of car platform, when on bumpers compressed, and bottom of pit. Pits must not be used for any purpose except elevator apparatus. Sidewalk, between bottom of pit and underside of platform, 6 inches.

Guides: Passenger, Freight and Sidewalk—Steel tongue and grooved or dowelled with wrought or cast iron brackets.

Safeties and Governor: Passenger—Over 100 f.p.m. toggle clamp safeties (gradual operating); 100 f.p.m. or under, instantaneous or roll-type safeties. No safety required for 15 ft. rise or under. Governor to trip at 40 per cent. above rated speed. Maximum tripping 850 f.p.m., minimum 150 f.p.m. Car-locking device required for safe-lifting elevators. Freight—Same as passenger. Existing freight, rise 5 stories or less, safety required but no governor required. Existing freight elevators with crosshead safeties can remain by furnishing governor. Sidewalk—None required on 35-ft. rise or under.

Car Enclosed and Platforms: Passenger—Existing and future installations, substantial enclosure, wood or metal, sides and top. On future installations if grill 1½ in. space, if bars 1 in. space. If space between car and counterweight is less than 2 in., enclosure to be solid over counterweight, or enclosure to be covered with ½-in. wire mesh, No. 16 gage, 6 ft. 6 in. high. In existing factory buildings wire mesh required on sides of car if in excess of above spacing. Folding gates or doors at each entrance (with contact and emergency cutout in car in rear of operator—future elevators only). Emergency exits—In future installations in top of car, 400 sq.in. in area, least dimension 16 in. Side emergency exits required in addition if two elevators in same hatch and vertical distance between any adjacent door openings exceeds 30 ft. In existing installations, emergency exit same as for future installations except in impractical conditions, Superintendent of Buildings will waive emergency exit provided egress can be had from floor openings or adjacent car. In future installations no auxiliary freight compartment allowed. Existing compartments must have gate with contacts. Cars to be lighted. Freight—Enclosures on freight cars not required except over counterweight unless in factory building. Underside of all platforms must be fireproofed. In existing and future factory buildings, enclosure on all sides not used for loading with substantial construction 5 ft. 6 in. high or to crosshead if less. If open construction is used, 1 in. space between members. Top of car to be No. 8 gage wire, 1½-in. mesh; to have self-closing hinged section at entrance 8 to 12 in. from sill (except where car gates are provided). Large hinged section permitted for handling long material. Gates are not required on freight elevators. If car has more than one opening and space between car and shaft exceeds 5 in., it is customary to furnish gate without contact at opening away from operator. In future installations no auxiliary freight compartments allowed. Existing compartments must have gates and contacts. Cars to be lighted.

Car Enclosures and Platforms: Sidewalk—Opening not more than 5 ft. from building line or more than one-twelfth width of street. Opening not more than 6 ft. long, parallel to building, without special permission from Highway Department. Platform not to exceed 50 sq.ft. Bow iron 6 ft. high permitted; if higher, special permission from Highway Department. No enclosure or gates required. Fireproofing underside of platform not required.

Gates: Passenger—In existing or future installations horizontal or vertical manually operated gates permitted (except push-button elevator) locked on shaft side, where elevator is surrounded by fireproof stair wall. Vertical-sliding gates to be 5 ft. 6 in. high, wood or metal, 2 in. between bars. 10 in. under clearance except at top and bottom floors may be more to give required head room. Existing shafts with trapdoors require gates. In factory buildings, existing and future installations, semiautomatic vertical-sliding gates to be furnished with swinging doors or doors with contacts or with interlocks. Freight—In existing and future installations in factory buildings only, vertical, semiautomatic gates, wood or metal 5 ft. 6 in. high, 2 in. between bars, to be used where swinging doors are used, or doors with electric contacts or interlocks. Existing shafts with trapdoors require gates. Sidewalk—Same as freight if there are intermediate floors.

Equalizers: Passenger and Freight—Permitted for overhead machines for car and counterweight.

Grating: Passenger and Freight—Required over future shafts under sheaves. Grating to sustain 75 lb. per sq.ft. Members spaced not more than 1½ in. apart. If machine is overhead, grating to be placed on top of machine beams. Deflecting or secondary sheaves and sheaves on sidewalk construction for passenger elevators to have grating under and on all open sides. Grating may extend over part of shaft 2 ft. 6 in. beyond bedplate or any machinery; to have screened railing 3 ft. high. Concrete slab permitted in lieu of grating. Trapdoor permitted in grating where other suitable access cannot be had. If penthouse door is more than 4 ft. above grating or roof, ladder required.

Counterweight Screens: Passenger and Freight—Existing and future installations, at top of shaft, length of counterweight, for drum machines only and where counterweight is in same shaft as car. Iron or steel No. 16 U. S. gage. Bottom screen 5 ft. high; bottom 18 in. above pit. Not required with counterbalance chains or ropes. In existing installations space between car and counterweight 1½ in. or less, no top or bottom screen required, but furnish 4 telltale chains on bottom of counterweight 5 ft. long, not over 6-in. centers from rail to rail.

Stop Motions and Shaft Limits: Passenger, Freight and Sidewalk—In future installations limit switches required on car or in shaft and on machines, on drum machines; shaft or car, traction machine; stop balls on rope hydraulic machines 150 f.p.m. or under, over 150 f.p.m. machines, for lever or crank operated hydraulic limits on machine.

Stop balls on rope or chain arranged to stop machine at terminal landings accepted by Building Department as shaft limit for sidewalk elevator, speed under 75 f.p.m. also machine limits required if drum.

Interlocks: Passenger and Freight—Required in existing and future installations in factory buildings only, either electric contacts to be used or swinging doors with emergency release in car or semiautomatic gates to be furnished. (See paragraph on gates.)

On all push-button elevators, standard push-button interlocks required. (Either No. 3 door lock or Wells-Van Alstyne for sliding doors.) Release for push-button elevators on landing side at all floors with key (except private house); release at lower landing only. Other mechanical or electro-mechanical interlocks permitted but not required. If mechanical interlocks are used, release must be provided outside shaft doors at each floor. (Ruling, Building Department, 10-21-18.) Sidewalk—No regulation unless rise more than one floor, then same as passenger and freight.

Emergency Switches: Passenger and Freight — Slack-cable device for drum machines only. Emergency switch in car. Emergency release for contacts. Sequence relay for mechanical control. Reverse-phase relay on all polyphase installations. Emergency call bell for push-button elevators. Sidewalk—Slack-cable device for both drums. Sequence relay. Reverse-phase relay on all polyphase installations. Waterproof-type warning bell 5 in. diameter to operate automatically by movement of car and warning sign not more than 10 ft. above sidewalk. Sign to read: "Danger—Look out for rising Elevator."

Hatchway Enclosures: Passenger and Freight—In future installations, to be inclosed in fireproof material full height if shaft pierces more than one floor. Shafts more than 9 sq.ft. sectional area shall be inclosed with brick 8 in. thick, concrete (stone or cinder), terra-cotta (hollow), concrete (hollow), gypsum (hollow), 6 in. thick reinforced concrete (stone or cinder), 4 in. thick, expanded metal or wire lath and cement mortar finished 2½ in. thick. Shafts extending into top floor of non-fireproof buildings to extend 3 ft. above roof, top to be fireproofed and to have metal skylight ¾ area of shaft or in lieu of skylight a window of same area in side of shaft 3 ft. above roof. If shaft does not extend to top floor, top to be fireproofed. Grill not less than No. 10 gage or expanded metal No. 13 gage 1½-in. mesh straight bars 1 in. between may be used in fireproof stair well. Existing grills to be covered with wire mesh or wire glass. Elevator hatchways piercing one floor only, existing or future installations, may be inclosed with grill No. 10 gage, expanded metal No. 13 gage or ⅞-in. thick wood slats spaced 1 in. apart, 6 ft. high. Existing elevators in non-fireproof public buildings to have fireproof shaft. Bottom of future shafts and existing shafts altered, to have fireproof construction. If machine is located at bottom of shaft to be protected by substantial pit pan. Not more than two elevators in one shaft. If only two elevators in building, must be in separate shafts. Sidewalk—Not required unless rise is more than one story; then shaft to be same as for passenger and freight elevators.

Hatchway doors: Passenger—In existing and future installations, doors to be latched from shaft side (push-button both sides). In future installations keys to be provided to unlock doors from outside in emergency. All fireproof shafts to have fireproof doors. Only one opening permitted in each story, and above each other, except doors may be located adjacent or opposite each other if door latch is not more than 48 in. from car switch. If more than 48 in., opposite or adjacent openings at first and top floor only. Gate contact required on car gate away from operator and a constant attendant at first and top floors. Attendant is not required on push-button elevator. No offsets on inside of shaft. Factory buildings only, future and existing installations, doors to be properly constructed sliding, or combination slide and swing, or swinging doors equipped with contacts, or swinging doors manually operated, or self-closing with auxiliary gates. (See gate paragraph.) Freight—All fireproof shafts to have fireproof doors. (Doors in factory buildings only to be same as for passenger elevator.) Sidewalk—None required except at sidewalk unless elevator pierces more than one floor; then same as freight elevator.

Trapdoors: Passenger and Freight—In existing buildings automatic trapdoors and guards must be furnished in any un-inclosed hatch and arranged to form a substantial floor cover when closed. Sidewalk—At sidewalk level to open and close by action of car.

Motor-Room Enclosure: Passenger, Freight and Sidewalk—Inclosed in same material as elevator shaft, lighted and have fire-doors at opening. Free and safe access to all parts of machinery; 12 in. clearance at stop limit on machine and motor end. Future installations in existing buildings, if sufficient space cannot be obtained, Superintendent of Buildings will grant modification. If machine is under shaft, pit pan to be provided.

Operator: Competent operator at least 18 years of age.

Installations Prohibited: Future installations, no belt or chain-driven elevators permitted for passenger service. Future installations, no auxiliary freight compartments above, below or side or similar device permitted on either passenger or freight elevators. Power-driven friction grip device prohibited on hand-power elevator when capacity exceeds 800 pounds.

Repairs and Alternations: Parts changed or altered to any elevator must comply with rules for future installations. Hand-power elevators changed to power-driven to comply with rules for power-driven elevators, except existing wood guides may remain if rise is not more than 35 ft. Removing elevator from old shaft to new is regarded as a new installation and must comply to rules for new elevators. Changing motive power of elevators may be done (if load and speed are not changed) without changing other elevator material. If freight elevators are changed to passenger elevators, they must conform to rules for passenger as regards safeties, ropes, capacity, car, enclosure, gates, exits, doors and door openings and motive power. If shaft is not enclosed, shaft and doors shall be enclosed as required for new elevators. Existing elevator with safety in cross head may remain if governor is furnished in connection therewith.

Anthracite Investigations in Senate Committee

The export situation and the production end of anthracite formed the principal topics discussed at last week's hearings before the Senate committee investigating the increased price of coal. A. S. Learoyd, assistant to the president of the Lehigh Coal and Navigation Co., in the course of his testimony said: "It is very difficult for the producing companies to answer any questions as to what the consumer pays for coal. Retail margins vary, and rightly so, because the cost to one dealer is different from the cost to another dealer in another city." Mr. Learoyd quoted the Bureau of Labor statistics of the Department of Labor to show that anthracite at the mine has increased in cost 51.5 per cent. over the pre-war cost. Owing to the customary advance of ten cents a month, costs in August had increased 62 per cent. This, Mr. Learoyd pointed out, was much less than the increase in most of the other necessities of life. The cry against increases in coal prices, in the view of the operators, is due largely to the fact that coal is sold by the ton. The large unit makes the increase more noticeable than would be the case if coal were sold by the pound, or even by the hundredweight.

In reply to questions Mr. Learoyd pointed out that coal-producing companies pursue the policy of declining to sell direct to the consumer. In support of this policy, he said that the retailer is a necessity in the distribution of coal. In addition to the difficulties presented by having to keep a multitude of small accounts, the operators feel, Mr. Learoyd said, that it is unfair to sell coal direct. The larger consumers would buy their coal direct if permitted to do so, but at least 50 per cent. of the population would find it impracticable or impossible to avail themselves of that privilege. This would mean that retailers would have to assess on this 50 per cent. of the population the total amount of their overhead and fixed charges, with the result that the poor people would be very adversely affected. It is by far preferable to distribute all overhead, taxes and other costs over 100 per cent. of the consumers in the community. The anthracite operating companies, he declared, are interested in keeping the price of the domestic sizes of the coal just as low as possible.

A report reached the committee that "in his wildest dreams no retail man ever hoped for such profits as the Government gave him." The report as to excessive profits was based on statements attributed to President Lloyd, of the Retail Coal Association of Pennsylvania. Mr. Learoyd regarded any such interpretation of Mr. Lloyd's remarks as unwarranted. What Mr. Lloyd did say, he declared, was "that the Government had done the retailer the greatest service by enabling him to know what his costs are; not to make money, but to keep his books, to figure his investment, his taxes and his overhead in such a way as to know what his costs are. I have yet to hear of a retailer who grew rich through profits made during the war. The retail trade as a whole made some money. Prior to the war a lot of them lost money because they did not keep their books properly."

Anthracite coal producers, Mr. Learoyd stated, while declining to sell direct to individuals, will sell to any coöperative organization, because such an association is a dealer. Whether a profit is made in their subdistribution is a matter that would not be taken into consideration by the operators.

S. D. Warriner, the president of the Lehigh Coal and Navigation Co., told the committee that anthracite is facing very dangerous competition in the use of gas, oil and coke. New houses, he said, are being equipped for the use of other fuels than anthracite.

Broken coal, Mr. Learoyd pointed out, is not in great demand this year because of the reduced activity of industrial and gas plants. He gave the demand as being about one-half that of last year. In spite of the decreased production this year, he said, there is in storage 1,200,000 tons of No. 1 buckwheat and smaller sizes. "We are ready to ship 400,000 tons of pea coal just as rapidly as it can be loaded."

Charles E. Lord

Charles E. Lord, general patent attorney of the International Harvester Co., died Sept. 25 at the Alexian Brothers Hospital, Chicago, from injuries sustained at the company's Deering Harvester Works the day previous. With an inventor of a sand-molding device, he was on his way to the foundry when the automobile in which he was going through the plant was struck by a switch engine. The machine was proceeding at a moderate speed when the switch engine came in sight, and at an apparently safe distance from the track the driver attempted to stop the car. Setting the brake tight locked the wheels and on a slippery, greasy pavement the car slid onto the track. The engine hooked on to the part of the automobile and dragged it for a distance of about twenty feet. Being on the side of the approaching engine, Mr. Lord attempted to get out of the car and at the time of the impact was knocked from the running board and dragged along with the machine, the rear end of the latter swinging around and closing the V between it and the engine, with Mr. Lord between. With severe internal injuries and a fracture of the skull at the base of the brain, he died twelve hours later.

Since 1912 Mr. Lord had been the head of the Harvester patent department. Previously, he had been an examiner in the Patent Office at Washington, and later was in the service of the General Electric Co. at Schenectady, N. Y., the Bullock Electric Co. at Norwood, Ohio, and the Allis-Chalmers Manufacturing Co. at Milwaukee, Wis., all of his work having relation to the patent requirements of these companies.

Having graduated from the Boston School of Technology in 1898, and later in a course of law at Washington, Mr. Lord brought into his work the rare combination of an expert engineer and a lawyer familiar particularly with the laws concerning patents, although well posted in other points of the law. Patient, steady attention to his angle of the business resulted in an even flow of success. He was a man of broad views, altruistic, modest and charitable in his attentions toward others. He was a capable adjuster and attained an enviable reputation in his line of work.

Last season Mr. Lord was chairman of the Chicago Section of the American Society of Mechanical Engineers. He was also a member of the Society of Automotive Engineers, Patent Lawyers' Association of Chicago, the American Bar Association and the American Institute of Electrical Engineers. Locally, he also belonged to the Old Colony Club, the University Club, and the North Shore Golf Club. He was born on Oct. 31, 1875, at Somerville, Boston, Mass., and is survived by a widow and three children.

Operating Performance in Electric Railway Power Plants

From data furnished by various electric railway companies the following information has been compiled by the Power Generation Committee of the American Electric Railway Engineering Association and was contained in the committee's report read at the convention held at Atlantic City, N. J., Oct. 6-10, 1919.

Curves were plotted from data furnished by 21 different companies to show the relation between plant efficiency and capacity. From these curves the values given in Table I were obtained. It may be noted that while the larger plants have the greater efficiencies, the increase in efficiency is much more rapid among the smaller plants.

Table II gives an idea of the distribution of the cost in plants of various size.

Table III shows a comparison of costs in the same plant for the fiscal year 1916 as against 1918. This plant had a two-hour capacity of 9300-kw.

Table IV gives the same information for a plant having a two-hour capacity of 24,000 kw.

TABLE I. RELATION OF SIZE OF PLANT TO EFFICIENCY

Two-Hour Plant Capacity	B.t.u. per Kw.-Hr. Generated	Thermal Efficiency, Per Cent.
Below 1,000 kw	90,000 to 80,000	About 4
1,000 to 3,000 kw	80,000 to 56,000	4.0 to 6.1
3,000 to 5,000 kw	56,000 to 43,000	6.1 to 8.0
5,000 to 10,000 kw	43,000 to 35,000	8.0 to 9.6
10,000 to 20,000 kw	35,000 to 33,500	9.6 to 10.0
20,000 to 50,000 kw	33,500 to 31,000	10.0 to 11.0

TABLE II. RELATION OF SIZE OF PLANT TO VARIOUS ITEMS OF COST

	Aver. Fuel Cost per Kw.-Hr., Cents	Aver. Labor Cost per Kw.-Hr., Cents	Aver. Maint. Cost per Kw.-Hr., Cents	Aver. Misc. Cost per Kw.-Hr., Cents	Aver. Total Cost per Kw.-Hr., Cents
3,000 kw. and less (6 plants)	1.85	0.43	0.13	0.15	2.56
3,000 to 5,000 kw. (5 plants)	0.96	0.25	0.09	0.15	1.45
5,000 to 10,000 kw. (4 plants)	0.77	0.15	0.08	0.05	1.05
10,000 to 20,000 kw. (9 plants)	0.76	0.14	0.10	0.05	1.05
20,000 to 50,000 kw. (10 plants)	0.75	0.11	0.07	0.05	0.08

TABLE III. COMPARATIVE COST FOR A SINGLE PLANT IN 1916 AND 1918

	1918	1916
Fuel cost per kw.-hr	$0.00539	$0.00222
Labor cost per kw.-hr	.00239	.00186
Maintenance per kw.-hr	.00053	.00042
Water, lubricants, etc., per kilowatt-hour	.00045	.00058
Total cost per kw.-hr	$0.00876	$0.00508

TABLE IV. COMPARATIVE COST FOR A SINGLE PLANT IN 1916 AND 1918

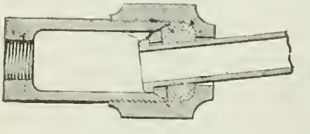
	1918	1916
Fuel cost per kilowatt-hour	$0.00749	$0.00320
Labor cost per kilowatt-hour	.00105	.00070
Maintenance cost per kilowatt-hour	.00103	.00360
Water, lubricants, etc., per kilowatt-hour	.00017	.00011
Total cost per kilowatt-hour	$0.00974	$0.00437

Condensed-Clipping Index of Equipment

Clip, paste on 3 x 5-in. cards and file as desired

Union, Berryman Expansion

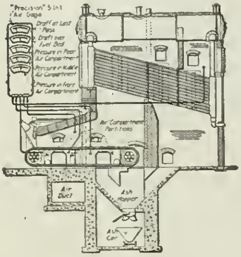
W. F. Berryman, Middletown, Ohio.
"Power," July 22, 1919



The union consists of two pipe diameters, one fitting within the other. One pipe is made with a flanged end, the outer edge of which is rounded. A gland surrounds this pipe. A packing ring with a rounded outer face seats on a like surface of the casing. The flat sides of the packing ring compress a packing substance when the gland is screwed up tight. As the opening in the gland is larger than the pipe, the latter can be considerably out of line and still maintain a tight joint.

Gage, Five in One Draft

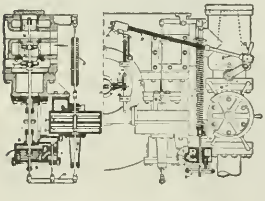
Precision Instrument Co., Detroit, Mich.
"Power," July 29, 1919


"Precision" 5 in 1 Air Gage
Draft at Last Pass
Draft over Fuel Bed
Pressure in Rear Air Compartment
Pressure in Middle Air Compartment
Pressure in Front Air Compartment
Air Compartment Partitions
Air Duct
Ash Hopper
Ash Car

This instrument consists of five gages so connected to the boiler setting as to tell the pressure in the first and third air compartments, the draft over the fuel bed and the draft in the last pass. The standard readings for the stoker draft are 0 to 2 in. of water, 1 in. vacuum to 1 in. pressure for the combustion chamber, 0 to 6 in. for the front air compartment, 0 to 4 for the center air compartment and 0 to $1\frac{1}{2}$ in. for the rear air compartment. Variation in pressure and vacuum are transmitted by diaphragms to a vertical adjustable plunger attached to a horizontal shaft by means of a link or lever.

Governor, Pneumatic Steam Turbine

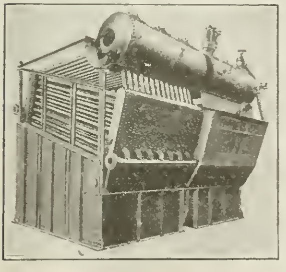
Ridgway Dynamo and Engine Co., Ridgway, Penn.
"Power," Aug. 19, 1919



In this governor the metal weights commonly used on governors are replaced by air, which also replaces the connecting linkage levers, etc., between the centrifugal element and the valves. The only running part is a plain disk with vanes on the side of it, which is bolted to the shaft. Air forms the connecting medium between it and the other moving parts, and these move only on a change of speed due to a change of load. A small pilot valve and piston move in oil and should therefore last indefinitely. The only work to be performed by the air piston is to operate a small $\frac{5}{8}$-in. diameter pilot valve which is balanced and floats in oil. The air force on two pistons is about 150 lb., thus making the pneumatic action of the governor powerful and reliable. The air pressure generated by the fan is as the square of the speed.

Heine Marine Cross-Drum Boiler

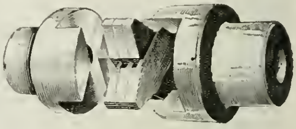
Heine Safety Boiler Co., St. Louis, Mo.
"Power" July 29, 1919



This marine boiler is of a cross-drum type and consists essentially of two flat steel headers and a cylindrical feed drum. The main bank tubes are $3\frac{1}{2}$ in. diameter and when the boiler is in position are inclined at an angle of 16 deg. to the horizontal. The feed drum varies from 36 to 48 in. in diameter. The seam is double-riveted, double-butt strapped longitudinal. The drum is fitted with a deflection plate. A scum pan of the "dish" type is also used, and surge plates are installed. There is a perforated dry pipe, the area of the slot exceeding the area of the outlet opening.

Coupling, Uniflex Shaft

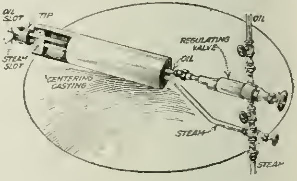
Uniflex Coupling Co., 246 Chestnut St., Philadelphia, Penn
"Power," July 22, 1919



This shaft coupling comprises two members. The shaft members are made with jaws which engage each other through a block that fits in between the face of the jaws. This makes a coupling that is insulated, shock-absorbing, and does not require lubrication. The coupling can be made self-adjusting for wear and can be operated in either direction. It is designed for any size shaft, horsepower and revolutions per minute.

Burner, Lockett Flat-Flame Oil

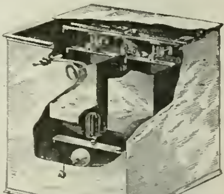
A. M. Lockett & Co., Ltd, 533 Baronne St., New Orleans, La
"Power," Aug. 19, 1919



This burner is of the so-called fishtail flat-flame type. The only wearing part is the tip, which is made of steel and is easily cleaned by removing one plug. The oil pipe is straight and can be cleaned without dismantling the burner. It is provided with a steam bypass for blowing out the tip and strainer when shutting down. Oil is discharged through a slot instead of an annular ring.

Water Weigher, Turner Automatic

The Water Weighing Machine Co., Inc., Piqua, Ohio.
"Power," Aug. 19, 1919



A steel tank containing two cast-iron rectangular weighing buckets with hopper bottoms and open tops. A float and valve maintains a constant water level in the storage tank. Water flows into one of the buckets and when filled to a predetermined height, the weight of water overcomes a counterweight; the bucket descends and by means of a lever the valve is moved, causing water to flow into the other bucket. The descent of the bucket also causes a ball valve to strike a stop, which pushes the valve from its seat and its buoyancy causes it to rise to the top of its cage. Water then discharges through the valve opening, and when the bucket is empty the counterweight again comes to normal position, and the water continues to discharge until empty.

Agitator, Negus-Tiffany Coal

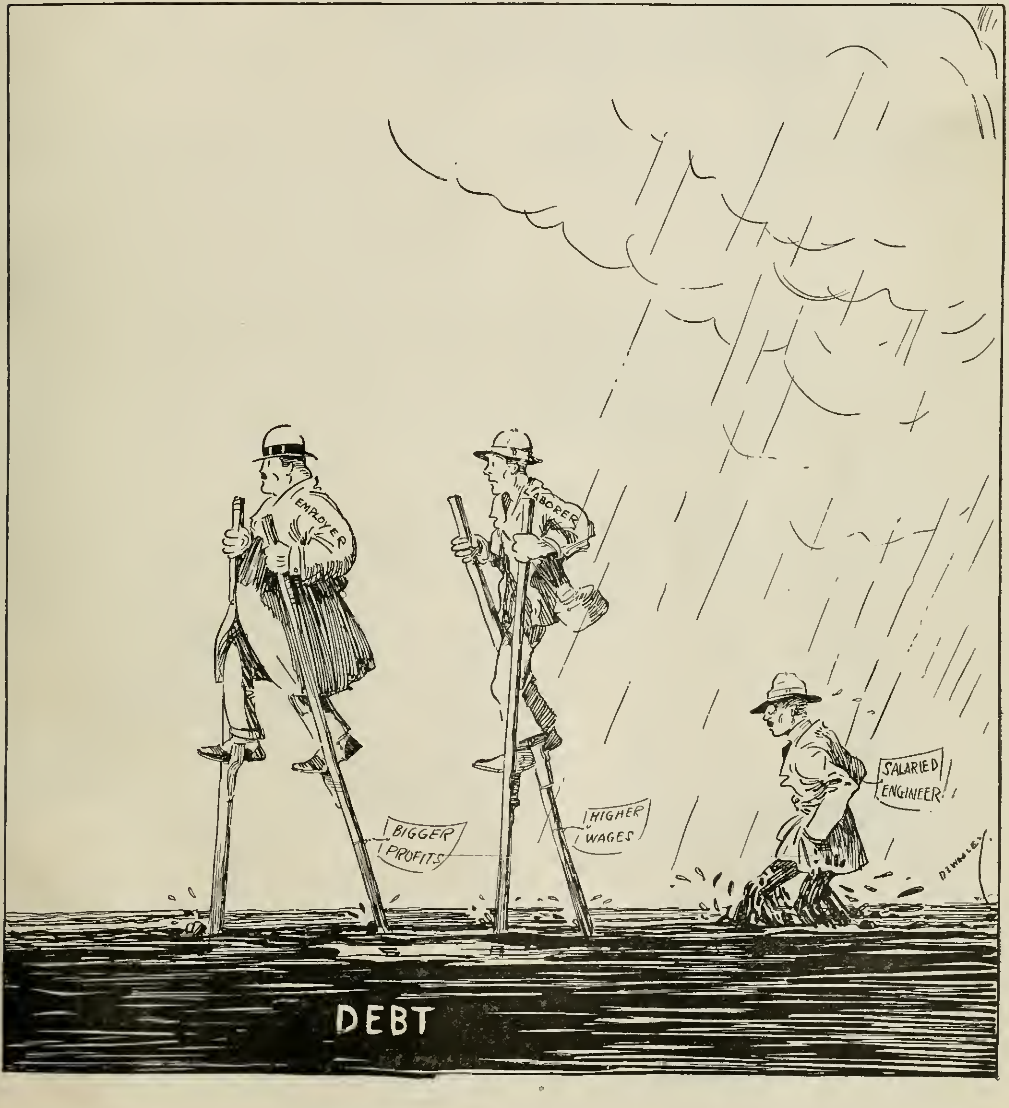
W. E. Ellis & Co., Haverhill, Mass.
"Power," Aug. 12, 1919

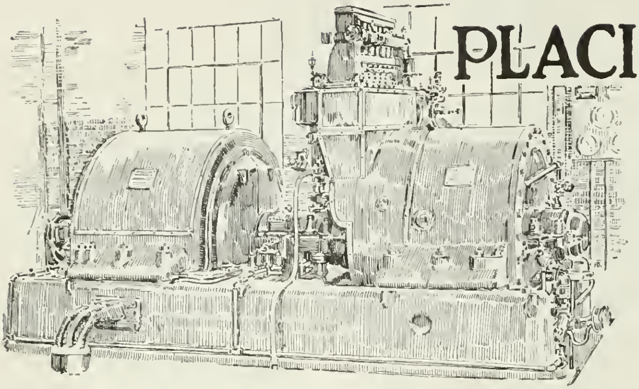
This stoker agitator consists of agitating arms, the number depending upon the size of the stoker and the number of stoker retorts. These arms are secured to a shaft that reaches across the bottom of the hopper, the agitator coming midway between the stoker plungers. One end of the agitator rod is connected by means of a bell crank and rod to the stoker ram shaft. The rod connection to the bell crank has a two-way motion, obtained by a special design of joints. The crank has a throw of 3 in. from center to center, which gives a 6-in. movement of the belt crank. The movement of the agitating arms across the bridge of coal formed by the stoker plungers undermines the packed coal and permits the plunger boxes to fill ready for the next forward movement of the plunger. This keeps a full charge of fuel in front of the rams.

Patented Aug. 20, 1918

POWER

Volume 50 New York, November 22, 1919 *Number 16*





PLACING A NEW TURBINE *in* SERVICE

By

Roger Taylor

The procedure followed in putting a steam turbine into service for the first time is discussed. Such features as leveling, alignment, checking bucket clearance, adjustment of thrust and step bearings, valve setting and governor adjustment are considered.

SETTING up and assembling of a new power-plant unit should be followed carefully by the operating force of the station, because the satisfactory operation of the machine in regular service will be so much more assured if some previous knowledge of it has been gained. Besides, the erecting engineer is usually qualified to give the operating engineer many suggestions regarding the unit as a result of his familiarity with every part of it.

The erection of a turbine unit begins with the setting of the base upon its foundation. The base is raised three-quarters to one inch from the foundation by means of wedges and distance pieces (Fig. 1) placed three or four feet apart under the base, to provide space for the final grouting after the unit has been satisfactorily lined up. The bearing pedestals are set in position, and by means of a line stretched through the bearings the alignment is checked and adjustments made by means of shims. With a slightly lower setting there, allowance is made for the effect of temperature upon the alignment of the steam end of the set. The generator bearings are customarily set slightly higher than the others, to bring any movement of the field toward the coupling rather than away from it.

After the leveling and alignment are satisfactory, the generator stator and other heavy parts are put in place, foundation bolts are tightened and the alignment is once more checked. Grouting is accomplished by raising a wall around the base on the foundation, as shown in Fig. 1, extending this wall far enough above the bottom of the base so that the grout mixture, when poured, will form a solid foundation.

When the generator field and the rotating element of the turbine are in place, the line-up of the coupling is checked. Care must be used here. The coupling should be checked between faces by using a taper gage (shown at *D* Fig 2), at several points around the coupling. By using a straight-edge along the edge of the coupling, as at *A* and *B* in the figure, the flanges may be checked. Perfect alignment must be obtained throughout the two spindles in order to reduce to a minimum the strains at the coupling. Other important points in the assembling of the unit are the adjustments of clearance, thrust bearing, valve motion and governor mechanism. The operating force should understand these adjustments, since later on, during the regular operation of the unit, they will be required to make periodic checks on the clearances and the wear on the thrust bearing.

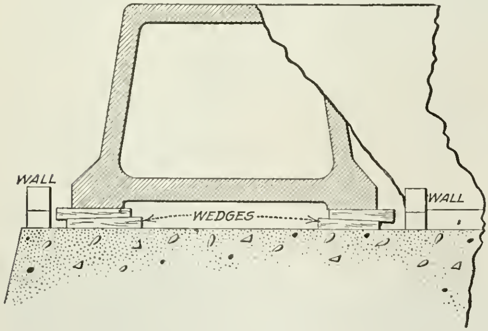


FIG. 1. METHOD OF SETTING BASE ON FOUNDATION

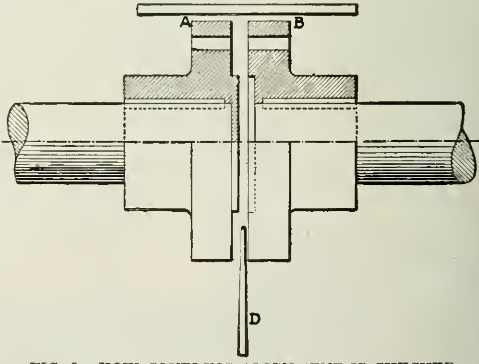


FIG. 2. HOW COUPLING ALIGNMENT IS CHECKED

In the Curtis turbine the clearance is equally divided on each side of the revolving buckets, or at least within the few thousandths of an inch permitted by the thickness of the material used for liners, the total clearance to be so divided varying with the size of the unit. The thrust bearing is so adjusted that a certain amount of movement, or float, of the spindle is possible—usually 0.0010 to 0.0015 in. Whatever design of thrust bearing is used, its purpose is to limit to a definite amount the movement of the spindle in either direction; so that with any given amount of float in the thrust the clearance between the stationary and the revolving bucket elements will be sufficient to prevent striking or rubbing. Owing to the wear on the faces of the thrust collars, the float of the spindle will be increased after a period of running, even with the best of lubrication. If the blade clearances are not correctly adjusted, serious damage to the blading from rubbing will result.

In the Parsons turbine, using dummy or balancing pistons on the rotor, as in Fig. 3, there is little rotor end thrust. Thrust-bearing adjustment is made to bring the balancing piston into the position that reduces to a minimum the leakage from piston to piston; allowing 0.008 in. to 0.015 in. float to give freedom to the collars revolving in the thrust boxes. The function of the balancing piston is to exert a balance against the pressure of the steam on the rotor, which otherwise would be forced into the direction of the steam flow. By this means end thrust is eliminated. Each succeeding drum of the rotor to which the blades are attached is made larger in diameter to accomodate the increased volume of the steam due to expansion. By means of an equalizing pipe each drum is connected to a balancing piston of corresponding area in such a manner that pressure is exerted on the piston in the opposite direction to the pressure on the drum. The thrust bearing consists of two cast-iron bodies having brass collars running in grooves on the shaft, as shown in the figure. The positions of the thrust blocks are set by means of two screws on the outside of the pedestal, one for each half of the block. The upper block is adjusted by its screw so that the labyrinth packing strips of the piston barely touch the labyrinth rings in the cylinder casing. The lower half of the block is then adjusted in the opposite direction to give the necessary float for the collars of the thrust.

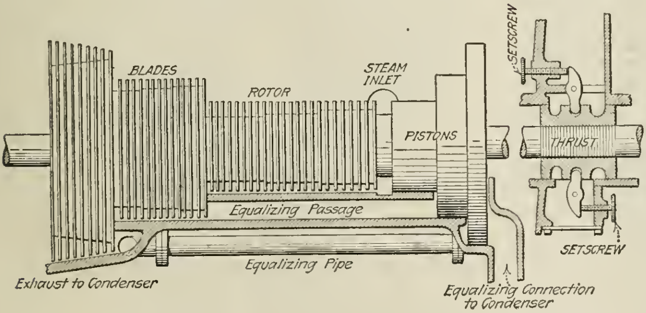


FIG. 3. SECTION THROUGH ROTOR AND THRUST BEARING OF PARSONS TURBINE

Fig. 4 shows one of the many types of thrust bearings used on the smaller machines. On each side of the bearing proper is a set of thrust collars consisting of two hardened steel plates, 1 and 3, and a roller collar, 2. Between the bearing and plate 3 are horseshoe rims, or liners, of sufficient thickness to give the necessary float. After the required float has been determined, the liners are divided on each side of the bearing to bring the blade clearances approximately equal. On this type of thrust all adjustments must be made with the bearing covers removed.

With the type of thrust bearing shown in Fig. 5, after the float adjustment has been made the thrust position relative to the blade clearance can be changed with the bearing covers in place, by means of the worm shaft shown; although the covers must be removed periodically to inspect the float adjustment and to apprehend undue wear on the roller plates. In the vertical machine the thrust arrangement is materially different. Owing to the fact that the whole revolving element of the unit must be supported and always held at the same height in order to maintain the correct clearance between the stationary and revolving buckets, a bearing known as the "step" bearing is employed.

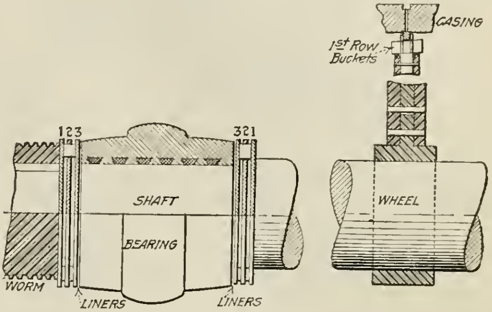


FIG. 4. THRUST BEARING FOR SMALL TURBINE

The essential parts of the step bearings, shown in Fig. 6 are the bearing blocks *B* and *B′*. The lower block *B* is held stationary by a key at one side and is supported at a given height by the large adjusting screw *S* passing through the center of the cover plate. The upper block *B′* is fastened to the turbine spindle *T* with which it is made to revolve by a key in the center of it and a dowel at either side. The upper face of this block is counterbored to fit the spindle. A fluid for lubrication, either oil or water, is fed through a pipe *P* inside the adjusting screw to the recessed space shown between the two blocks. By means of the adjusting screw the position of the revolving wheels relative to the stationery wheels is changed.

To facilitate the checking of the wheel clearances, a hole is made in the turbine casing opposite the first-stage wheels, for the insertion of the taper-gage, as shown in Fig. 7. With a thrust bearing having outside adjustments, such as the one in Fig. 6, the clearances may be taken with the machine rotating. To do so, the spindle is raised by means of the adjusting screw, until a slight rub is noticed on the wheels, then the screw is backed off until a similar rub is noticed in the opposite direction, and halfway between the two rubbing points is taken as the center of clearance. Such an adjustment must be made with extreme care, and at the first indication of rubbing, the adjusting screw must be backed off to move the spindle in the opposite direction.

The important item in setting the valve motion and governor mechanism is to so adjust the pilot valve that all valves are open when the unit is at rest; and to limit the travel of the valve-cam rack to that point in order that no overtravel may occur and that all valves will be open when the unit is at maximum load. When the unit is at speed but without load, no valves should be fully open and only one partly open to maintain speed; in other words, the unit must be under governor control. No serious wiredrawing of the steam will then occur, because all the valves except one must always be in either a wide-open or closed position. Overtravel of the camshaft, with its consequent locking of the mechanism, may be prevented by blocking under the piston, which operates the camshaft through the rack, so as to give no more than a full cam travel. Usually, this is taken care of in the design of the machine by a device such as the hydraulic cylinder, shown in Fig. 9. The valves are of the globe type, Fig. 8, and are opened by the cam raising the lever against the tension of the compression spring. Sufficient tension must be given the compression spring on the valve lever to restore the valve solidly to its seat.

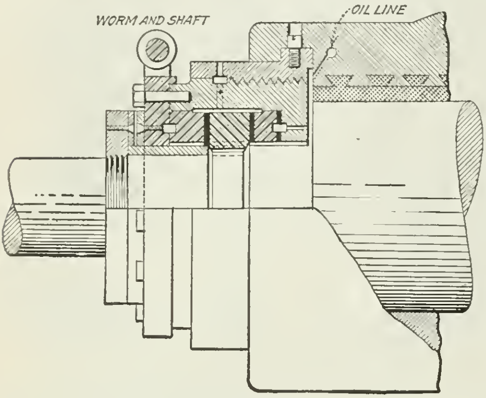


FIG. 5. THRUST BEARING THAT CAN BE ADJUSTED BY A WORM AND GEAR

Although all governor adjustments are made at the factory, further adjustments usually will be necessary on the governor spring tension to obtain the desired speed range. This adjustment is made on the tension nut of the main spring. After the assembly of the governor the various rods and levers to the pilot valve are connected and the pilot valve is brought to its normal position. Being without lap, the correct position of this valve is directly opposite the port openings to the hydraulic cylinder.

The governor and valve operation may be seen from Fig. 9. When the turbine is at rest, all valves are open, the hydraulic piston at the end of its stroke and the pilot valve in its mid-position relative to the ports. As the unit approaches the speed at which the centrifugal force of the governor weights overcomes the tension of the main-governor spring, the governor beam connected to the spindle will be lowered and, by its connection to the floating lever of the pilot valve, will lower this valve in its bushing. As this valve has no lap, the slight downward movement will open the top port over the piston to exhaust and the bottom port to allow the oil to pass under and raise the piston. By means of its connection to the pilot-valve piston rod through the floating lever, the outer end of which forms a fulcrum on the connecting-rod to the governor beam, this slight raising of the hydraulic piston restores the pilot valve to its original position of closing the ports. The raising of the hydraulic piston will have rotated the valve camshaft enough to partly close the valves. Should this movement be insufficient and the unit continue to accelerate, the operation will be repeated until only enough valves are open to maintain the proper speed.

Similarly, a reduction in the speed of the turbine will raise the governor beam and pilot valve, thus lowering the hydraulic piston and opening the valves. The pilot valve, while directly under the control of the governor, is limited in its travel by the hydraulic piston through the floating lever. Any movement of the governor weights immediately results in a slight movement of the pilot valve, which in turn causes the position of the piston to be changed, reacting on the pilot valve and restoring it to its mid-position. In the operation of the unit lost motion in the governor mechanism must be kept at a minimum so that immediate response will be made to any change in speed. The governor transmission bearing should be cleaned frequently to obviate the possibility of sticking.

When the assembling of the unit, with its auxiliaries, its steam, oil and water piping, has been completed, preparations will be made for the initial run. The steam line will be blown out, up to the screen, which should be placed ahead of the throttle valve so as to clean the steam lines of scale and foreign matter. An inspection is made to insure that the camshaft bearings, the rollers of the valve gear and the governor-transmission bearing have been properly lubricated. The lubrication system will be checked and the proper quantity of turbine oil placed in the oil reservoir. The

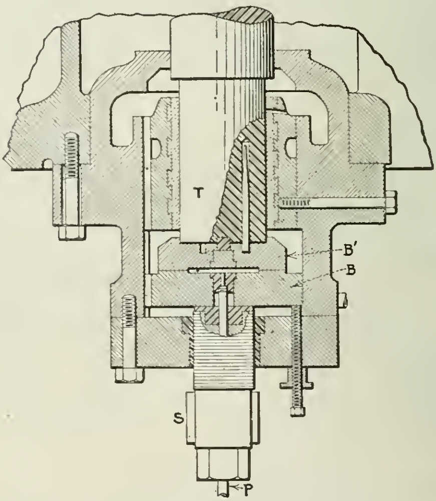


FIG. 6. STEP BEARING FOR VERTICAL TURBINE

oil system will be tried out by starting the auxiliary oil pump, which is always used in starting the unit, so that the bearings may be lubricated by it until the speed of the unit is sufficient for the main oil pump to supply the lubrication. The auxiliary oil pump should be controlled by a pressure regulator in the steam line and its throttle open, so that in the event of failure of the main oil pump, the lubrication will be at once taken care of, before damage can result. The relief valve from the oil lines exhausting into the oil tank is adjusted to give the correct pressure in the governor's hydraulic cylinder, which is approximately 75 lb. The step-bearing pressure will be adjusted by the baffler reducing valve, the bearing water-cooling system tried for water leaks into the oil system. Inspection will be made to determine that the screens are in place over the oil suction in the tank. Inspection will also be made of the steam lines to the carbon packing of the seals, to see that they are connected and the valves adjusted.

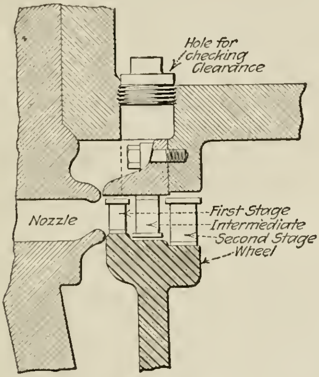


FIG. 7. HOLE IN CASING FOR CHECKING CLEARANCE

While a general survey is being made to see that all tools, forms and blocking have been removed, the unit may be heated by passing a small quantity of steam through it for a short time, and the auxiliaries started up. For some time after being first turned over, the unit is run at reduced speed, and during this time careful watch must be kept on all parts of it, particularly the bearing temperatures.

When the speed of the unit is being increased, attention must be given to its balance. Although the turbine wheels and generator rotor were balanced at the factory, this balance may have suffered during shipment or erection. When a unit shows considerable unbalance, it is sometimes necessary to disconnect the coupling and remove the generator's rotor while the turbine's rotor is being balanced; after which the generator's rotor is replaced and the unit balanced as a whole until it is satisfactory at all speeds.

As the unit approaches full speed, the governor action must be noted to see that all valves are opening and closing properly and that the unit is under control. If the valve action does not take place at the proper speed and the pilot-valve and camshaft adjustments were properly made, the speed of the machine must be lowered by decreasing the tension on the main governor spring; while if the unit comes under governor action before it is at speed, this tension must be increased. Ordinarily, the governor weights and springs under tension are so nearly correct for the desired speed that there is ample room on the mainspring nut for any adjustments necessary, which should be within a narrow range. During these speed tests the auxiliary synchronizing spring should have its bottom plug at about mid-stroke. The governor-speed range test should now be taken, to ascertain the effect on the speed of the unit exercised by the auxilary synchronizing spring.

The unit having thus far satisfactorily operated, a test is made on the overspeed device for tripping the automatic throttle. This test is made by bringing the unit 8 or 10 per cent. above normal speed, by closing the oil supply to the hydraulic cylinder, causing all valves to remain open. The machine is brought to speed and allowed to accelerate until it is at 8 or 10 per cent. overspeed. Should the tripping device fail to operate then, the throttle must be tripped by hand and the unit brought to rest. The tension of the spring may then be reduced, and the overspeed trial repeated until the trip operates at the desired point. This device is so important as to deserve constant attention to insure that it is in proper working order and that the unit is free from the danger of overspeed.

Soon after the unit has carried load, a complete record should be made of its economic conditions and the results checked against those guaranteed by the manufacturer. With a steam-flow meter on the main-steam line and thermometers located at essential points—the steam-line and steam-exhaust outlet, the injection-water inlet and discharge, the air-pump suction and discharge, and, if a surface condenser, on the hotwell—these instruments together with those on the switchboard will enable the operator to check the steam consumption of the unit against its load and thereby ascertain how closely the actual performance of the machine approaches its guarantees. Particular note must be made of the vacuum to see that the back pressure is kept at the proper figure. All exhaust piping should be checked and leaks reduced to a minimum.

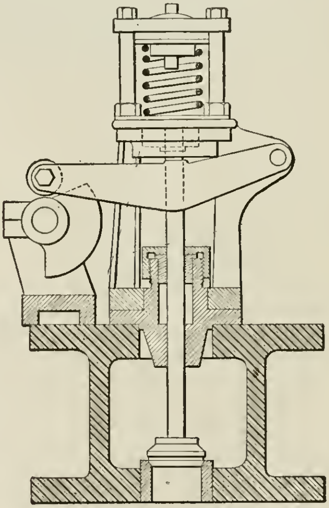


FIG. 8. SECTION THROUGH STEAM TURBINE VALVE

The condenser should then be studied to determine its best performance at the various loads, and these results checked against those guaranteed by the manufacturer under similar conditions, particularly those of the injection-water temperature and the steam flow into the condenser. Allowance must be made in any apparent discrepancy between the actual steam rate of the unit and that guaranteed for it, due to abnormal contributing conditions, such as vacuum, steam temperature, steam pressure; since all these values were carefully kept standard during the factory tests.

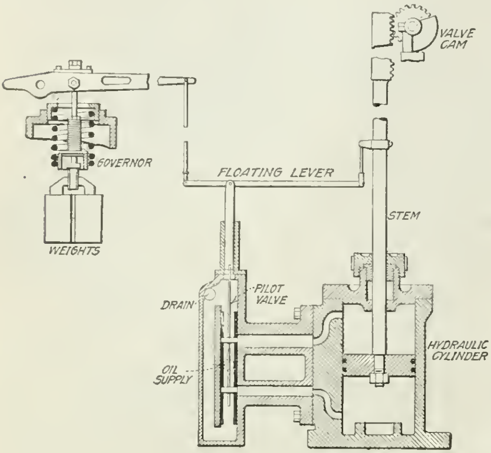


FIG. 9. VALVE-CONTROL MECHANISM

(The next article will discuss the procedure followed in putting an alternating-current generator on the bus for the first time.)

Removal of Soot From Chimneys

By D. M. Riff

American Steam Conveyor Corporation

It has often times been called to the attention of engineers and plant operators that the accumulation of soot in the bottom of the chimney is detrimental owing to the smoldering fire that frequently occurs and is even a constant menace because of the danger of explosion.

A simple and inexpensive device has been in use for a long time in many plants for keeping the bottom of the stack clean. It is a steam-jet conveyor of small diameter installed with the suction line under the bottom of the stack and the discharge line into the ash bin or pit. The illustration indicates a typical arrangement.

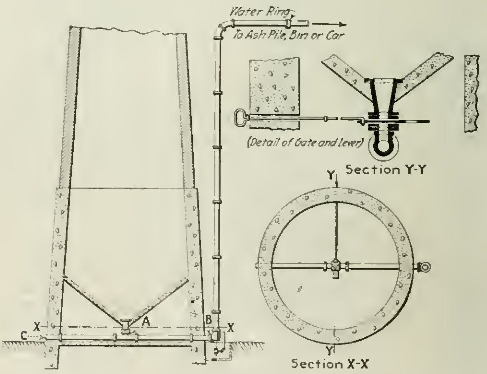
A hopper bottom is built in the existing stack with an opening in the bottom, under which is placed a specially designed intake tee fitting *A*, with a machined box and slide, air-tight gate. This gate is operated by a rod and lever from the outside of the stack wall. The intake tee, of course, is part of the conveyor line proper, which rises at *B* to sufficient height to discharge into the ash bin or pit, over a slope into a valley, or, through a properly designed target box into a cart or wagon.

At the foot of the riser *B* is inserted a steam unit fitting consisting of a body and an end and back cover plate, provided with renewable wear liners which may be replaced by removing the back cover. The bottom cover is drilled and tapped for a nozzle holder and nozzle. The upper bend consists of long-radius type elbows to prevent the possible packing or clogging of the fine flaky soot after it comes in contact with the steam. In the discharge line is placed a properly designed water-spray ring to allay the dust at the discharge end. The air supply is provided through the inlet at *C*.

The operation of the equipment is simple and practically automatic. The valve is turned on in the steam line leading to the nozzle, and in the water line leading to the spray. The expansion of the steam as it rushes through the nozzle creates a suction in the horizontal line. The operator opens the slide gate by means of the outside lever, and the soot flows by gravity into the intake opening. It is conveyed by suction to the point *B* and from there is discharged by the steam through the riser and horizontal discharge line.

Inspection door or peek holes above the hopper are unnecessary because the conveyor operates by sound. When the steam is turned on and the conveyor is running empty, there is a roaring noise as the air rushes into the inlet *C*. As soon as the gate at *A* is opened and the material begins to flow into the conveyor, the sound dies out and does not reappear again until the bottom of the stack is empty. When the roar begins again, the operator closes the gate and then turns off the steam and water valves.

The usual steam-jet conveyor used for disposal of ashes and cinders will not work successfully in removing the soot from the stack base. The soot, compared to ashes, is very fine and flaky, without any real body or surface. A very much higher velocity of the air is therefore required to move this material. This higher velocity is practically impossible in the large-diameter pipes used for handling ashes and clinkers.



ARRANGEMENT OF CHIMNEY SOOT REMOVAL SYSTEM

These conveyors have been in operation for a number of years in large power plants and central stations. They have also been further adapted for the removal of combustion ashes from the back passes of boilers, and of soot from breachings, flues and economizers.

Induction-Type Overload Relays—Their Operation and Application

BY VICTOR H. TODD

Discusses the construction and operation of an overload relay, in which a movement similar to a watt-hour meter is used to obtain a protective device of high accuracy. Transfer relays are also considered.

WHEN the great possibilities of adequate protection were seen, and when it was realized that to obtain this protection a more accurate relay than the plunger type was required, the induction-type watt-hour meter was looked to as a solution of the problem. The voltage winding of the watt-hour meter was displaced by a current winding, and contacts were arranged to close when the current reached a certain value. The torque, or turning effort, of the disk was opposed by a spiral spring. The magnetic and electric circuits of a relay of the induction type are shown in Fig. 3. *A* is the main winding, and under this is another winding similar to the secondary of a transformer, which supplies the polepiece windings *B* and *D*. The path of the magnet flux is indicated by the dotted lines.

Fig. 1 shows a standard induction-type relay and Fig. 7 a schematic diagram of parts as viewed from the top. The disk *A* is mounted on the shaft *B*, is actuated by the electromagnets *C* and is damped by the permanent magnets *D*, in a manner similar to a watt-hour meter, except that both windings on the electromagnet *C* operate from the current of the line alone, as in an ammeter. Instead of the disk revolving continuously when current is applied, the rotation is opposed by the spiral spring *I* fastened with its outer end to the permanent support *E* and its inner end to the shaft, which also carries the moving contact *F*. When sufficient current flows through the electromagnet *C* to develop in the disk the necessary torque, it rotates until the contact *F* touches contact *G*, thereby completing the trip circuit.

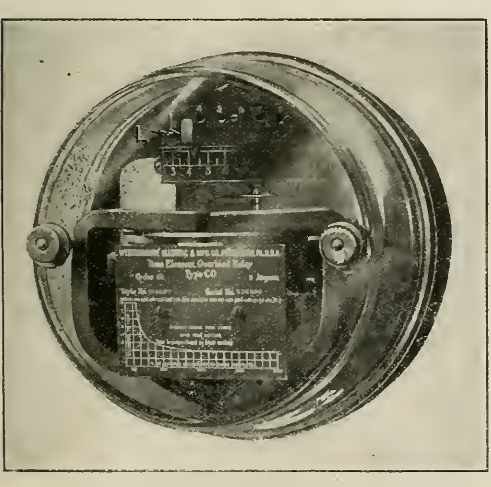


FIG. 1. WESTINGHOUSE INDUCTION-TYPE OVERLOAD RELAY

The foregoing describes the induction-type relay without its present refinements. It had great accuracy, but one great drawback was that the moving contact "floated." That is, the load might be sufficient to turn the disk half way around, so if the relay was set to operate on 5 amperes, and the load was 4.5 amperes for some time and then suddenly increased, the closing of the contacts would be almost instantaneous, because 4.5 amperes caused the contacts to "float" near to the tripping point. To overcome this, several holes were cut in the disk, beneath the poles of the electromagnets. These holes decreased the torque considerably, but once the current became high enough to move the disk slightly, the holes were moved out from under the poles, and the latter then acting on the solid metal, caused the disk to revolve until the contacts were closed. This insured an inverse time limit on all overloads, as the disk was always at its starting point until an overload occurred. As all circuits could not be set to trip on the same overload, taps were brought out on the current coil, which enabled the operating current to be varied over a wide range, a common range being 4, 5, 6, 7 and 8 amperes.

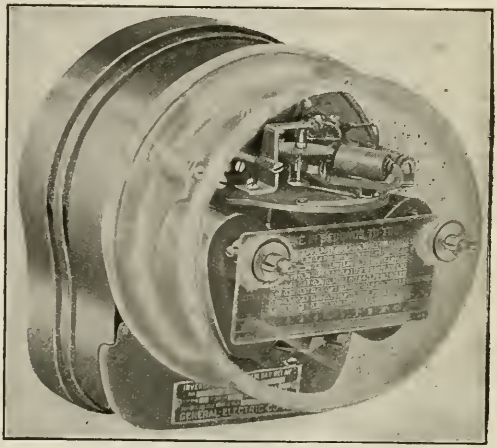


FIG. 2. GENERAL ELECTRIC INDUCTION-TYPE OVERLOAD RELAY

In the induction-type relay, Fig. 1, the taps are changed by inserting a screw in a marked plate, Fig. 4, to make contact with the desired tap. The metal piece *D* has five tapped holes to receive the screw *B*, which may be put in any hole and make contact with the taps *C*. *A* is the main coil wound on the electromagnet and has the taps *C* brought out at the correct turns to give the desired operation. The block *E* is of insulating material and is arranged so the taps cannot pull out.

As has been pointed out previously, it is sometimes desirable to have an inverse-time limit on moderate overloads and a definite-time limit in the case of severe short-circuits. This combination of inverse time on moderate overload, gradually decreasing to a definite time on heavy overloads or short-circuits, is met in the induction-type relay by the use of a small transformer called a "torque compensator."

This torque compensator is introduced into the secondary circuit as shown in Fig. 6. The main winding *A* carries the main current as in Fig. 3 and, by its transformer action, induces a current in the primary *B* of the small transformer. On the opposite side of the core *C* is the secondary *D* which supplies the polepieces *E* and *E′* with the necessary current to react on the main flux, or magnetism, from the pole *F* produced by coil *A*. At moderate loads the current in *D* will increase in proportion to *B*, but the iron in *C* is of a cross-section such that, after the current in coil *B* passes a certain value, the core becomes saturated, consequently the current in *D* cannot increase no matter what the overload may be. Since the current in the coil cannot increase above a definite value, the torque on the disk is limited, which results in a definite time on heavy overloads.

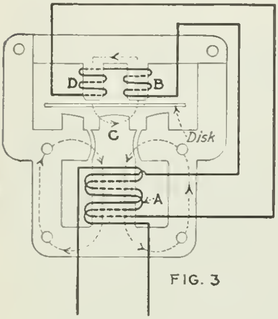


FIG. 3

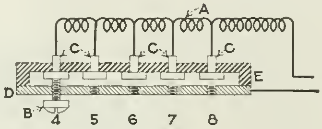


FIG. 4

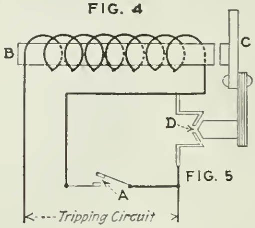


FIG. 5

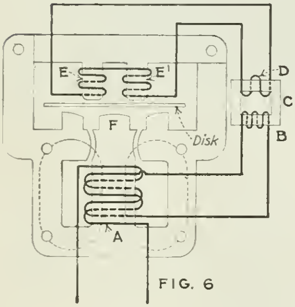


FIG. 6

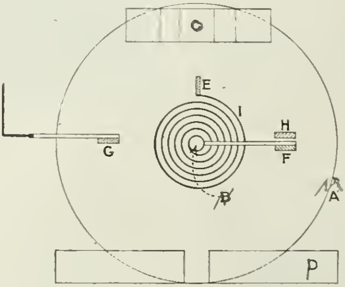


FIG. 7

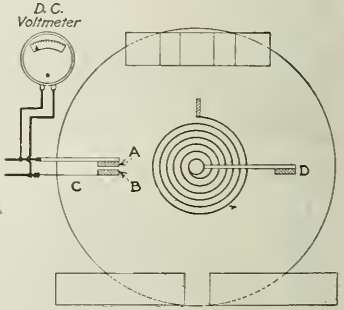


FIG. 8

FIGS. 3 TO 8. DIAGRAMS OF INDUCTION-TYPE RELAY CIRCUITS AND PARTS

It is essential in the protection of radial and ring systems that the time of the relay be variable. To accomplish this, the angle through which the contact must travel is varied. Thus, if the contact must travel one-half revolution, it may take two seconds, but if a stop *H*, Fig. 7, is arranged so that the contact need make only one-fourth revolution, the time may be halved. Other positions, easily set by the lever *L* shown in Fig. 1, enable any time from instantaneous to a maximum to be readily set.

A typical curve for an overload induction relay is given in Fig. 9, reference to which will show that 150 per cent. load takes about 10 sec. for the relay to close its contact, 200 per cent. load requires about 5 sec.; 500 per cent., 2.75 sec.; 1000 per cent. and any overload in excess of this takes a definite time of about 2 seconds. These values are taken at the highest time setting; if the setting is halved, the time is halved. In other words, the time is almost proportional to the lever settings.

In the induction-type relay shown in Fig. 2 the principle of operation is the same as that in Fig. 1. The various current settings are obtained by the use of a small plug, instead of a screw, which makes contact with the various taps. The markings on the time-lever scale are arbitrary, but as will be seen from the figure, any chosen time may be set by reference to the table on the front of the relay.

The contacts of overload relays, necessarily being small, due to the high accuracy required are not designed to open the trip circuit once it is established.

Take, for instance, a circuit-breaker that requires 0.2 of a second to open after the trip coil has been energized. Suppose the relay should make contact, but before the breaker could open, the short cleared itself. Then the relay, instantly attempting to reset, would open the contacts and produce an arc. To prevent this, as well as to transform a light contact into a positive one, a separate contactor switch is used, as shown in Fig. 5.

The main relay contacts *A*, when they close the tripping circuit of the relay, energize a small coil *B* that attracts an iron armature *C* and closes the contacts *D*, which are in parallel with the main contacts *A*. Thus it will readily be seen that even though the contacts *A* should open, the current will pass through *C* and contacts *D* will stay closed until the breaker opens the circuit. Then the coil *B* will lose its pull and open contacts *D*. When a very large breaker is to be opened, it is sometimes necessary to install a relay switch, but this is an unusual condition.

To prevent the spiral spring of the movable element from carrying the tripping current, two contacts are placed near each other, as in Fig. 8. Contact *A* is stationary while *B* is mounted on a thin flexible strip *C*. Then when the disk turns, the arm *D* strikes contact *B*, forcing it against *A*, and completes the tripping circuit.

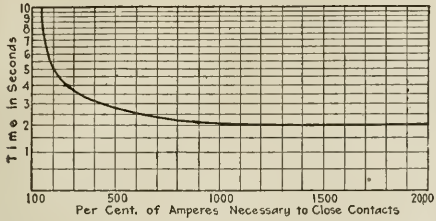


FIG. 9. CHARACTERISTIC CURVE OF INDUCTION-TYPE RELAY

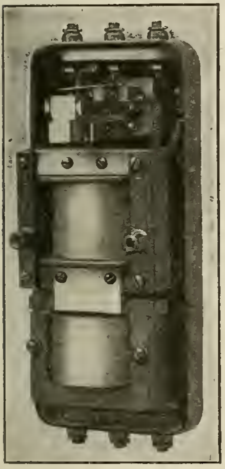
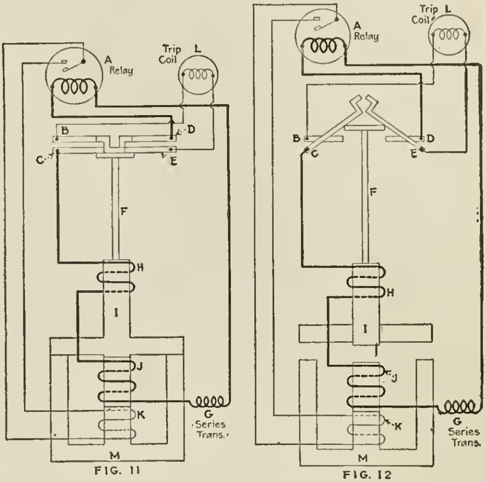


FIG. 10. TRANSFER RELAY

Some companies connect a small voltmeter across the contacts, as in Fig. 8, in order to tell by its continuous indication that the trip circuit is alive up to the contacts. Should the meter fail to indicate, the operator knows immediately that the trip circuit has failed. In other cases a small telegraph relay is connected to ring a bell when the trip circuit becomes dead.

To prevent failure from the foregoing source as well as to apply relays where a direct current is not available, series-trip or circuit-opening relay may be used, but their inherent fault of opening a breaker on slight vibration has discouraged their use. However, by using a "transfer relay," as it is called, the advantage of the series-trip relay may be obtained without its drawback. Fig. 10 shows one of these relays and Figs. 11 and 12 a diagrammatic scheme of parts. *A* is a standard circuit-closing relay of a type similar to those in Figs. 1 and 2. The contacts on the upper end of the shaft *F* are arranged so that *C* makes contact with *D*, while *E* makes contact with *B*, in normal position Fig. 11. When the plunger is pulled up, *C* makes contact with *B* while E makes contact with *D*, Fig. 12. The current from the series transformer *G* passes through the relay *A* and through two coils in the transfer relay. Coil *H* tends to raise the plunger *I*, but coil *J* tends to hold it down, and since the current in both coils is equal, the plunger will not be moved.

Wound on the same core with coil *J* is another coil *K* with its terminals connected to the relay contacts. When the relay contacts close, they short-circuit coil *K*, which has set up in it a current by the transformer acting coil *J*. This current being in opposition to the current in coil *J* tends to demagnetize the core *M* and it loses its attraction for the plunger *I*, allowing coil *H* to pull it up. This changes the switches at the top to the position shown in Fig. 12. It will now be noted that the current is flowing through the trip coil *L*, which will trip the breaker.



FIGS. 11 AND 12. DIAGRAMS OF TRANSFER RELAY IN NORMAL AND TRIPPING POSITIONS

Fig. 13 shows three single-phase relays protecting a three-phase line in connection with three transfer relays. When the plungers are all down, the trip coil is entirely insulated from the series circuit. If any one, two or three relays operate, they will complete a circuit through the trip coil and current transformers under any conditions that may arise. The overload relay *A* gives the necessary accuracy, while the transfer relay gives the advantage of a series-trip or circuit-opening system.

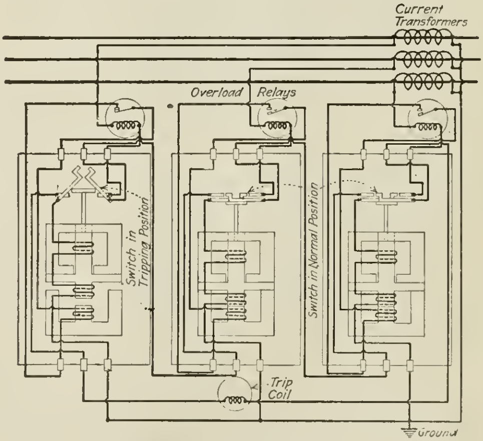


FIG. 13. DIAGRAM OF TRANSFER RELAYS CONNECTED ON THREE-PHASE CIRCUIT

Care of Small Refrigerating Machines

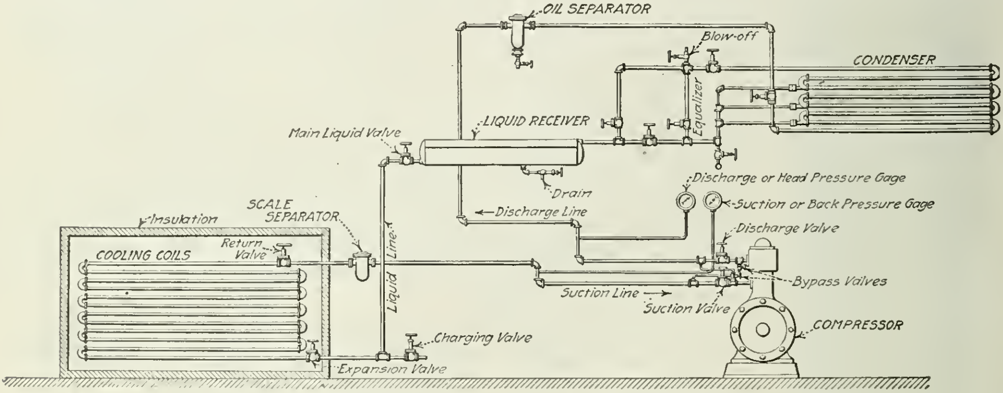
By FREDERICK J. BYRNE

COMMON difficulties occurring in the operation of refrigerating machines, their causes and remedies, are given in tabular form, and are fully explained in the text following the numbered paragraphs.

1. The correct amount of condensing water is about three gallons per minute per ton of refrigerating capacity of the machine with a 9-deg. range of temperature of water flowing to and leaving the condenser.

To determine whether the condenser pressure is too high, reference must be made to an ammonia table giving the properties of saturated ammonia gas. A condensed ammonia table is given here:

It will be noticed that for every temperature of the gas there is a corresponding pressure. Assume that the temperature of the condensing water leaving the condenser is 70 deg. F. The high-pressure gage should show a pressure corresponding to 8 or 10 deg. higher or about 80 deg. F., which is 139.40 lb. If the pressure shown on the gage is higher than this, the causes given in the table should be investigated.



PIPING CONNECTIONS AND APPARATUS IN TYPICAL SMALL REFRIGERATING PLANT

2. If a double-pipe condenser is used, examination of the water pipe, which is the inner pipe, should be made to see that it is not clogged with slime or incrusted with scale. The surface of atmospheric condensers should be examined for the same conditions. Double-pipe condensers should be located in as cool a place as possible.

Atmospheric condensers should be placed so that they are protected from the direct rays of the sun and so that they will get the benefit of the prevalent summer winds. The wind will cause some of the condensing water to evaporate and thus cool the rest of the water, with a resultant lowering of the condenser pressure.

In some localities the wind is so strong that it will blow the water off the condenser, resulting in increased pressure. To avoid this and to protect the condenser from the direct rays of the sun, a slatted housing is sometimes built over the condenser, which allows the wind to enter but breaks its force.

3. Before deciding that air or noncondensable gases are present in the system, the operator should be thoroughly satisfied that the excessive pressures are not due to the causes mentioned in one and two of the table, because too frequent purging is one of the greatest sources of high ammonia consumption and waste.

It is customary to purge by having a valved connection at the top of the condensers from which a connection can be run to a pail of water. As long as bubbles can be seen rising noncondensable gases are being discharged. When ammonia starts to blow off the water absorbs it, the bubbles stop and a crackling sound can be heard. The purging valve should be closed immediately when this occurs.

If there is too much refrigerant in the system, the gage-glass on the liquid receiver will show too high a level. The correct level when the plant is in operation and doing its greatest amount of refrigeration should be specified by the manufacturer who installs the machine.

To reduce the amount of refrigerant in the system, a connection should be made from the drain pipe on the liquid receiver to an empty ammonia tank and the liquid allowed to drain out until the proper amount is present. Care should be taken not to fill the ammonia shipping tank too full. Do this by weighing it as the liquid receiver is drained.

4. Reference to the ammonia table and inspection of the gage-glass on the liquid receiver will determine whether this trouble exists. Ammonia should be added through the charging valve of the system, care being taken not to add too much.

5. This condition causes inefficient operation because it results in the gas being superheated instead of saturated. Saturated gas is gas in contact with its liquid, and its volume per pound for a particular pressure corresponds to that given in the ammonia table for that pressure. Superheated gas is gas not in contact with its liquid and occupies a greater volume per pound than that corresponding to its pressure. For example, we see, by reference to the ammonia table, that at 15.67

lb. pressure a cubic foot of vapor weighs 0.1107 lb. or that a pound of ammonia vapor has a volume of 9.028 cu. ft. when saturated. If superheated, it will have a greater volume than this per pound, depending on the amount of superheat. This superheat is due to the difference in temperature between the gas, which is cold, and the rooms through which the suction pipe passes, which are comparatively warm. Because of this difference in temperature the gas is heated, therefore its volume increases. If liquid were present this heat which leaks in would simply supply the latent heat required to evaporate the liquid instead of heating the gas and thus increasing its volume.

With superheated gas, therefore, the compressor pumps a smaller weight of gas per revolution with resultant falling off in capacity.

Under the usual operating temperatures correct conditions will show frost, indicating the presence of liquid, on the suction line just up to the compressor, and the discharge pipe will be fairly hot to the hand.

6. The conditions under 6 of the table cause inefficient operation because they result in liquid returning to the compressor. If liquid is coming back it will evaporate on the suction stroke and prevent gas from being drawn into the compressor, reducing its capacity. Also, liquid coming back will cool the stuffing-box, cause the packing to contract, and leakage of gas will occur. Do not tighten up on the stuffing-box, but close the expansion valve somewhat until liquid stops coming back.

TABLE I. AMMONIA COMPRESSOR TROUBLES, THEIR CAUSE AND CORRECTION

	Trouble	Cause	Remedy
1	Too high condensing pressure.	Too little or too warm condensing water.	Supply more or cooler water to condenser.
2	Too high condensing pressure.	Condenser coils fouled with scum or scale.	Scrape condenser coil clean.
3	Very high condensing pressure, trembling of the pressure gage and condenser pipe. Temperature corresponding to the pressure considerably higher than the condensing water discharge temperature.	The presence of air or noncondensable gases in the system or too great a charge of refrigerant.	Blow-off air or noncondensable gases. Take ammonia out of the system.
4	Too low condensing pressure.	Too small a charge of gas.	Add ammonia to the system.
5	Rapid fall of suction pressure. Increase of condenser pressure.	Expansion valve closed or open too little.	Gradually open expansion valve till correct condition is obtained.
6	Too high suction pressure. Discharge connection cold. Heavy frost on compressor.	Expansion valve too wide open.	Gradually close expansion valve till correct condition is obtained.
7	Loud hammering of compressor valve.	Broken spring on compressor valve.	Put in new spring.
8	Irregular action of compressor valves.	Dirty or leaky compressor valves.	Overhaul valves.
9	Capacity of compressor reduced.	Leaky piston.	Overhaul piston and cylinder.
10	Stuffing box and discharge pipe too hot.	Expansion valve closed or open too little.	Open expansion valve wider very slowly.

Where the load on a refrigerating machine varies frequently, it is difficult to pack a rod tight because part of the time, when the load it light, liquid may come back, which causes contraction of the packing and leakage. At other times, when the load is heavy, gas comes back superheated, the packing expands and friction is greatly increased because an ammonia stuffing-box is comparatively deep. This friction increases the power consumption and will carbonize the packing.

With a varying refrigerating load as described, if a stuffing-box is tightened when liquid is coming back, it should be slacked off when the suction is dry. Close attention to and regulation of the expansion valve will eliminate a large amount of stuffing-box trouble.

The adjustment of a stuffing-box is a matter of experience with the particular installation to be taken care of.

When the expansion valve is too wide open, the compressor shows too much frost and the discharge line is cold to the touch.

TABLE II. CONDENSED AMMONIA TABLE

Temperature, Deg. F.	Pressure, lb. per Sq.In.	Latent Heat of Evaporation, B.t.u.	Weight of Vapor Lb. per Cu Ft.
100	200 42	492.01	0.7153
80	139.40	505.05	0.5205
60	92.89	517.93	0.3697
40	58 29	530.63	0.2554
20	33 25	543.15	0.1711
0	15 67	555.5	0 1107
—20	3 75	567 67	0 0690

7, 8 and 9. To make these repairs to valves, etc., it is necessary either to pump out the compressor or to close both the main suction and discharge valve and to allow the ammonia to escape either through the valve provided on some compressors or through an open joint.

To pump out the compressor, close the main liquid valve and then the suction valve. Run the compressor for a few minutes. Stop it immediately and close the discharge valve tight. The bypass valve on the discharge line should be opened and closed immediately. The valve for the purpose of allowing ammonia to escape from the compressor can now be opened, or if such a valve is not provided, a joint can be slowly loosened. The compressor can now be taken apart for inspection and repairs.

10. See 5.

Hunting of Synchronous Machines

By Arthur Hearvey

When two alternators are operating properly in parallel, the current flows as in Fig. 1. The voltages are equal and opposite with respect to the closed circuit of the two armatures and their leads, and therefore there is no current circulating between them. If one of the machines, say *B*, should slow down, the current would flow as shown in Fig. 2. The two voltages are no longer exactly opposing, and a circulating current flows between the two armatures. While this circulating current does not exist continuously, but only during certain parts of the alternation, it is convenient to consider its effect separately. It can be seen from Fig. 2 that this circulating current is in the same direction as the voltage of *A*, and there-

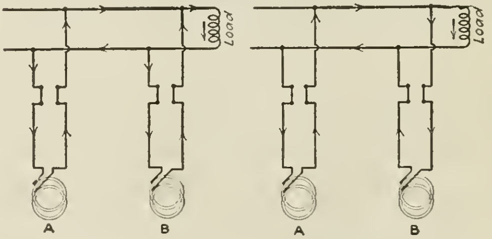


FIG 1 FIG 2

FIGS. 1 AND 2. ALTERNATORS CONNECTED IN PARALLEL fore acts as an additional load on this machine and causes it to slow down. Since the circulating current is in opposition to the voltage of machine *B*, the load is decreased on this unit, causing it to speed up, and the two machines tend to come together, as in Fig. 1, when they are in step and there is no circulating current. However, owing to the momentum of the swings they will swing beyond the position of no circulating current and a current will flow in the opposite direction. The frequency of this swing is called the natural vibration of the machines. If the machines are direct-connected to engines whose angular velocity is variable, forced oscillations will be impressed on the machines. If the period of oscillation of the engines is within 20 per cent. of the natural frequency of the generators, cumulative swinging will be produced and the machines will be thrown out of step and shut down unless powerful dampers are used.

The magnetic flux in the field or stator produced by the direct-current winding is practically constant in value. However, during hunting the flux is driven back and forth across the pole face in time with the hunting. This action does not occur while hunting is not present. The shifting of the magnetic flux is due to a change in the relative positions of the revolving magnetic field of the stator and the geometric center of the direct-current pole. Therefore, if a low-resistance closed-circuit winding is placed around the poles or embedded in the pole-faces, as in Fig. 3, current will be induced in this closed circuit by the shifting of the main field. This induced current, in turn, produces a magnetic field which will prevent or oppose the shifting of the main field, thereby assisting in preventing hunting.

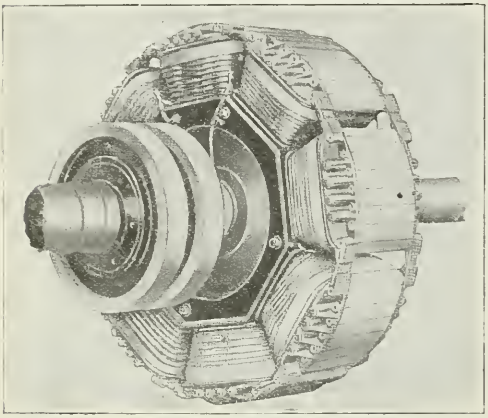


FIG. 3. SHOWS SHORT-CIRCUITED WINDING EMBEDDED IN POLE FACES

If there is an ammeter in the busbars its reading should be the sum of the readings of the individual ammeters, in which case there is no hunting; but if its reading is less than the sum of the separate meters, the difference is the synchronizing current that is circulating between the alternators and holding them in step.

Atlas Boiler-Tube Cleaner

A tube cleaner for use with return-tubular boilers, which is made to operate with either air or steam, has been developed by the Atlas Manufacturing Co., San Francisco, Calif. It is made for tubes from 2 in. to 6 in. in diameter. The machine has two plungers operating at right angles to each other, as shown in Fig. 1, and deliveries approximately 10,000 direct taps per minute, the length of the stroke being about three-eighths inch. This rapid tapping causes a constant vibration which cracks and jars loose the scale.

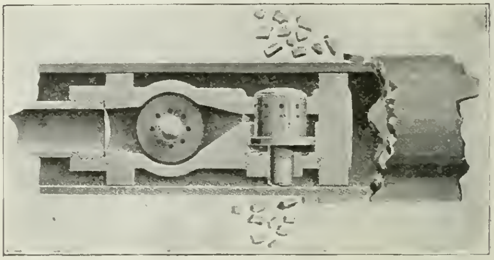


FIG. 1. CLEANER FOR RETURN-TUBULAR BOILERS

The driving fluid enters the cleaner through the center tube, which is provided with a strainer. With the piston in the position shown, the air or steam enters the small lower ports and escapes through the ports shown at the bottom of the left-hand piston. As the area of the bottom surface of the piston is greater than that around the larger piston head, the piston is forced upward, exposing the upper ports, which permits the air or steam to escape to the outside of the cleaner. When this occurs, the pressure on the upper surface of the piston forces the plunger down, and pressure is again admitted to the under side of the piston and the cycle is repeated.

For cleaning tubes of water-tube boilers a different type of cleaner, Fig. 2, is employed, designed to use either water, air or steam. The rotor is positively driven and has no dead center. It carries a blade that runs longitudinally with the center of the shaft, traveling in a position parallel with the bore of the cylinder. Steam enters at the right, flows through the passages shown at the top and is admitted to the space between the center ring, the rotor and the longitudinal plate at the center. The pressure causes the rotor to revolve, and the water, air or steam escapes through suitable ports to the front of the cleaner and around the cutter head, which is secured to the threaded end of the center shaft.

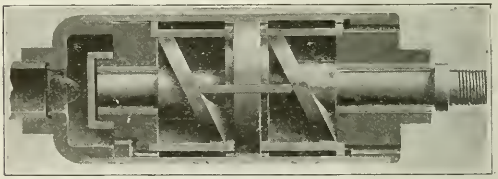


FIG. 2. ROTOR OF CLEANER USED FOR WATER-TUBE BOILERS

Boiler-Room Essentials

By H. F. Gauss

Increasing capacity by installing stokers. Saving effected pays large returns on investment. Use of superheaters and economizers. Simple instrument equipment properly located recommended. Losses from high flue temperatures.

IN THE past it has been characteristic of steam-power plant engineers to pay a great deal of attention to the economy of the prime mover and neglect to a large extent the boiler room. The steam engine and turbine have been brought to a high standard of efficiency, and whatever future improvements may be made, the corresponding gain in efficiency will necessarily be small. On the other hand, the opportunities for saving in the boiler room are large. Boiler efficiencies ranging from 50 to 60 per cent. are common, and the returns possible by installing efficient and labor-saving equipment in the boiler room fully warrant the investment necessary.

Installation of additional equipment in the engine room will sooner or later necessitate more capacity in the boiler room, and unless the latter is already equipped with modern stokers and coal and ash-handling machinery, the logical move is to provide this equipment throughout, instead of adding to the present uneconomical apparatus.

Consider, for example, a boiler room containing six 350-hp. hand-fired boilers, four of which are in constant operation. Tests show that an efficiency of 60 per cent. is maintained and three shifts of two firemen, two coal passers and two ashmen are required. A good grade of egg coal is necessary, and constant attention must be given the fires to maintain even 60 per cent. efficiency.

By installing automatic stokers with coal- and ash-handling machinery, the operating force can be reduced by one-half and an efficiency of 70 per cent. secured, a cheap grade of coal can be burned and a more uniform condition of operation maintained. The comparative cost of operation is given approximately in the accompanying table:

COST OF HAND-FIRING VS. STOKER OPERATION

Old Equipment	
6 firemen at $5 per day	$30.00
6 coal passers at $4.50 per day	27.00
6 ash men at $4.25 per day	25.50
80 tons egg coal at $3	240.00
	$322.50
New Equipment	
3 firemen at $5 per day	$15.00
3 coal passers at $4.50 per day	13.50
3 ash men at $4.25 per day	12.75
79 tons screenings at $2.75	217.25
1 oiler at $5 per day	5.00
	$263.50
Saving per day	$59
Saving per year	$21,535

Assuming an investment in new equipment of $100,000 it follows that:

Interest on investment at 6 per cent	$6,000
Depreciation at 4 per cent	4,000
Upkeep at 2 per cent	2,000
	$12,000

Deducting this $12,000 from the annual saving still leaves $9535, or nearly 10 per cent. above what might be considered a fair return on the money. The gain is more than could be obtained ordinarily on a safe investment.

A typical installation consists of a track hopper into which dump-bottom cars are unloaded. A short cross-conveyor is arranged to carry the coal from the track hopper into a crusher, which in turn discharges the coal into a bucket conveyor. The crusher is provided with a bypass around the rolls and into the main conveyor, to be used in case the coal does not require crushing. The main conveyor is arranged to convey the coal from the crusher and distribute it in overhead bunkers, from which it drops through spouts into the stoker hoppers. The bucket conveyor passes directly in front of the ash doors in the ash tunnel, and the ashes from the various ashpits are hoed directly into it to be conveyed up into the ash burner.

The secret of a successful installation is the providing of ample room for repairing and replacing broken or worn-out parts of the machinery. Permanent platforms and ladders providing easy access to the equipment are indispensable to proper maintenance.

With a uniform load the chain grate with natural draft is a desirable stoker for the bituminous coals mined in the Middle West. Where the load varies and peaks must be met, the chain-grate stoker with forced draft should give better results. One especially favorable feature in connection with the forced draft is that it makes the installation of an economizer possible. With natural draft only, unless an exceptionally high stack is available, the advantage of an economizer is doubtful.

Superheaters are successful when they are located in a sufficiently hot zone of the setting. It is a mistake to assume that a superheater can take the place of an economizer. Sufficient heat head to cause the heat to flow into the steam does not exist in the cooler zones of the setting and breaching generally occupied by the economizer. The proper location for the superheater in horizontally baffled boilers is in the combustion chamber behind the bridge-wall, and not in the comparatively cool last pass or breaching. In vertically baffled boilers, the proper location is at the top of the first pass.

When it is considered that the specific heat of superheated steam is about 0.55, while that of the flue gases is 0.24, and that about 24 lb. of flue gases result per pound of coal burned, it is evident that the amount of heat actually adsorbed by the steam due to its superheat is comparatively small. Thus in a 350-hp. boiler using coal containing 11,500 B.t.u. per lb. and operating at 60-per cent. efficiency, the following results obtain:

Total steam per hour, lb	10,500
B.t.u. absorbed by steam, due to its being superheated 100 deg	577,500
Coal per hour, lb	1,680
Total flue gas per hour, lb	40,320
Reduction in temperature of flue gas, due to heat absorbed by steam, deg. F	59

In comparison with an economizer the superheater, then, does not materially lower the gas temperature, and as often pointed out, the advantage of superheated steam over saturated steam is not due to the additional heat it contains, but to its improved properties.

The efficiency of a boiler and its furnace depends on five fundamental conditions: Proper draft, complete combustion, air-tight settings, clean heating surfaces and low flue temperatures.

In order for these conditions to obtain, the stack must be of the proper size and height, and the breeching must have proper area, be free from sharp bends and as short and direct as possible; the furnace and combustion chamber must be designed and built to suit the particular fuel to be burned; the brickwork or casing enclosing the boiler must be tight, free from cracks and air leaks, and the heating surfaces must be kept free from scale and soot.

The fundamental apparatus necessary to see that these conditions are maintained are: Draft gages connected over the fire and in the breeching, an Orsat apparatus, sufficient soot blowers and tube cleaners and pyrometers. It is the writer's opinion that the simpler the instrument equipment the better will be the results secured by their use.

A separate recording pyrometer in each boiler breeching is desirable. Nothing is more detrimental to economy than high flue temperatures. For instance, consider the 350-hp. boiler used to illustrate in the discussion of the superheated. There were 40,320 lb. of flue gases per hour. An increase of 50 deg. in the temperature of these gases leaving the boiler means that 483,840 B.t.u. are wasted per hour. This is equivalent to 42 lb. of coal, or 2.5 per cent. of the coal fired. In many plants flue temperatures are as much as 150 deg. higher than necessary, which is an avoidable loss of 7.5 per cent. The continuous record given by the recording pyrometer is the best means of keeping check on this source of loss.

In many cases the hand Orsat is more desirable than the CO_2 recorder, when the engineer on watch is required to make gas analyses at least once an hour and is required to see that these analyses show reasonable percentages of CO_2. That is, if he makes an analysis and finds the CO_2 low, he must at once determine the cause, have it corrected and secure the normal analysis. In large plants operating 10 to 20 boilers, this is not practicable and the recording apparatus must be resorted to, with an expert devoting his entire time to the instruments in the boiler room.

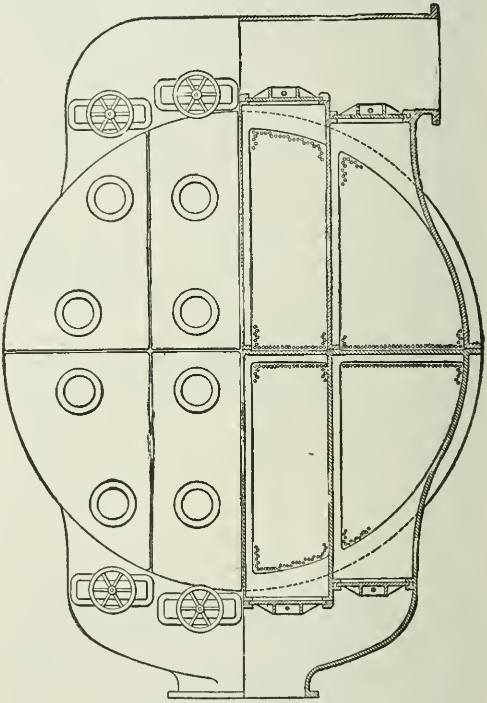
The final evidence of boiler efficiency is, of course, the pounds of water evaporated per pound of coal fired, and no plant is complete that is not provided with a coal scale and feed-water meter. For uniform flow, such as is secured by centrifugal boiler-feed pumps, the venturi meter is the desirable boiler-feed meter. However, with reciprocating pumps some form of "V" notch meter is preferable, as there is some question as to the accuracy of the venturi meter under a pulsating flow. In water-works pumping stations where the feed water is supplied by a number of reciprocating pumps driven by the individual pumping engines, a fairly uniform flow is obtained and the venturi meter has been found satisfactory.

It is desirable that where more than one boiler is needed to carry the load, every unit be operated at least to its rated capacity. It often happens that one or two boilers carry most of the load, while the others are allowed to run light. Indicating steam-flow meters attached to each boiler nozzle are valuable, as they show exactly what each boiler is doing.

In laying out a boiler room it is essential that all gages and controlling apparatus be located in as convenient and accessible places as possible. The damper lever should be brought to the front of the boiler and arranged so that the fireman can keep his eye on the draft gage while regulating the damper. The draft gage, steam flow meter, steam-pressure gage and water columns should all be visible from the same point in front of the boiler.

New Compartment Condenser

A new development in the shape of a compartment steam surface condenser has been made by the Wheeler Condenser and Engineering Co., Carteret, N. J. It can be cleaned while in service without shutting down the turbine. Any tube or tubes may be temporarily plugged and other repairs made without taking the condenser out of service.



SHOWING CONDENSER COMPARTMENTS

The illustration shows how the condenser is divided into four compartments, each being equipped with a set of valves to control the circulating water. To clean the condenser while the turbine is delivering full power, the operator shuts off the water from one compartment, removes the cover, cleans the tubes, replaces the cover, turns on the water again and then passes on to the next compartment, repeating the operation until the four compartments are clean. Thus, while one compartment is being cleaned, the others are in full operation, temporarily taking over the turbine load.

EDITORIALS

James Watt Memorial

IN THE account of the James Watt Centenary Celebration, appearing in this issue, mention is made of the proposed Watt Memorial. As stated, this is to be in three parts: A research professorship at the University of Birmingham, a memorial building and a memorial volume. The appeal for funds for the chair of research is to be made to the whole world.

This request has a special appeal to the engineering profession on two grounds—first, as a tribute to the man who made modern power engineering a possibility and, second, as a means of continuing the advancement of the industry.

The debt that engineers owe to James Watt can hardly be estimated. Other men used steam before Watt, but he seems to have been the first to apply its expansive force and to condense the steam outside the engine cylinder. It is true his apparatus was crude, in the light of modern practice, but his was the idea. If he had never lived, some other man might have done his work, but the fact remains that he did live and that he did do his work, and how well he did it is evidenced by the fact that one of his engines is still at work.

In giving praise to Watt, no credit should be withheld from the many who have followed and developed his ideas, but credit for the pioneer work must go to him. Many great names live in American history for glorious deeds done for the public welfare, but it was Christopher Columbus who had the vision and the pluck to follow his vision, with the result that a new continent was developed. Likewise, many names will always live in the history of steam-power engineering for contributions to the development of the art, but it was Watt's vision that produced the foundation on which they worked.

From a purely utilitarian standpoint an endowed research department deserves strong support. The art of power engineering has reached what, to many, seems to be a high state of perfection. The demands on the art, however, are increasing even faster than its development. If civilization is to progress, not only must this art continue to progress, but the progress must be speeded up.

The greater the advancement in any line the more difficult it becomes to continue development. The obvious improvements are soon made, and the possible ways of advancement become more and more limited. Progress can be made only by long, hard study. This research cannot be self-supporting. Often years of hard, conscientious work give only negative results. A theory is simply disproved. An idea that promised much is found to be useless. This work does not bring any financial return to the worker, but its importance to the community is often beyond price. A list of "don'ts" is often as valuable as a list of "do's," but the latter are what bring the money.

Many large industrial organizations have research departments that have done wonderful work. Much of the knowledge gained by this work has been freely given to the public, but it is often confined to perfection of existing apparatus rather than the exploration of new fields. What the world needs is more and more "scientific explorers" who are not hampered in the necessity of making their work pay immediately in dollars. Such work can best be done in the endowed research departments in the various technical schools and universities. A large amount of such work is done there, but the field is so large that only the surface has been scratched, and as a rule, the funds are limited. It is in the hope of helping in this necessary work that the promoters of the Watt Memorial have planned to collect funds for an endowment to provide and maintain a school of research "in the fundamental principles underlying the production of power and the study of the conservation of the natural sources of energy."

This appeal, which is made to all the world, should find a favorable response in the United States and especially among the engineers who owe so much to James Watt. Contributions may be sent to the Hon. Secretary, James Watt Centenary Committee, Chamber of Commerce Building, New Street, Birmingham, England.

Why Not a Representative Group?

BROADLY speaking, everybody with very few exceptions, belongs to one of two classes—the employer or the employee. Some belong in both. But regardless of their business affiliations, all have a public interest at stake, and the time has arrived when the great body of safe and sane citizens will see to it that the public dominates. If capital and labor cannot agree, the public will do the deciding and force compliance.

Any decision, however, if it is to have the full backing of public opinion, must be made by a properly constituted and representative body.

When labor bolted the recent Industrial Conference, the public group was requested to continue the work. It made a feeble attempt and then, realizing the futility, gave up the task. But had it possessed the temerity to continue, it is doubtful if the verdict would have been accepted as a basis for procedure in dealings between industry and labor. Not that many of its members weren't of the highest standing and intelligence, but the group was hardly representative of the public. Indeed, it is doubtful if any personally selected group, whether chosen by the President or any other man, could thus be truly representative.

Would it not have been better in appointing such a body to have requested the great national bodies such as the combined engineering societies, the Bar Association, the Chamber of Commerce, etc., each to nominate a man and the group thus formed, supplemented if necessary by a few personal appointees, would have had the backing of all professional and business interests and the respect of labor.

It has been hinted that a second industrial conference may be called. If so, it is hoped that some such procedure will be followed.

Correspondence

Handling Superheaters During the Starting-Up Period

An answer to F. L. Richards's question on "Handling Superheaters During the Starting-Up Period," in the July 29, 1919, issue, page 193, may depend somewhat on the method of installing the apparatus originally. Superheaters are installed in three general ways. First, those provided with a flooding pipe connected with the water space of the boiler and also with a drain line for bleeding the water out of the superheaters. Second, those with only a drain line on the superheater for discharging any water in it, and third, those with no drains.

I have operated the two first-named types but the third—the one without a drain line—I would like to hear full particulars about it from someone who has used it.

The idea of a flooding pipe is to keep the superheater full of water during the starting-up period of the boiler, or at other times when the boiler is not working, should the operator find it desirable. In handling this type of apparatus I have always kept the usual air valve open in the boiler to expel the air while the water was being slowly heated to the atmospheric boiling points. During this period the drain valve on the superheater was kept closed and the valve in the flooding line open so that water was able to circulate freely through the superheater elements.

When steam began to issue from the air valve it was closed and the steam pressure allowed to rise. Just before the boiler was ready to be cut in service the valve in the flooding line was closed and the superheater drain valve opened wide, so that all water could be blown out of the superheater. This drain valve was then partly closed, some steam being allowed to blow through to prevent burning the superheater tubes. Then, after cutting the boiler in service, the drain valve was closed tight.

In handling superheaters with only a drain valve I always close the air valve on the boiler when starting up and open the superheater drain valve wide, until the boiler starts to steam. Then I choke off the drain valve while the steam pressure is rising until after the boiler is cut in service, when it may be closed tight.

If a boiler is warmed up slowly until it begins to steam and this steam is allowed to blow through the superheater and out of the superheater drain line, I see very little advantage in having the flooding arrangement; as steam circulating through the superheater and out of the drain will prevent any burn-outs. The only advantage of the flooding pipe is that it protects the superheater from overheating up to the time the boiler starts to steam. After this point is reached, circulation of the steam through the superheater and out through the drain is just as effective. If an engineer handles a superheater this way he will have no trouble with burn-outs.

A point not exactly in line with the question under discussion is the superheater safety valves. These are supposed to be set to blow off at a lower pressure than the main safety valves, to protect the superheater from burn-outs in case the load suddenly drops and no steam is taken from the boiler, especially when there is a very hot fire in the furnace. Yet some engineers will use extreme care during the starting up period to prevent burn-outs of their superheaters and take a bigger chance by setting down on the superheater safety valve so that it never blows. WARREN D. LEWIS.

New York, N. Y.

In the plant where I am employed are boilers carrying 200 lb. pressure with 100 deg. F. superheat. Some time ago one of the boilers was down for cleaning and was then turned over to the operating crew.

In our plant each superheater is equipped with a pop safety valve besides the ones on the boiler proper and has a ½-in. bleeder pipe discharging to the atmosphere. When a boiler drops out of line or when the automatic valve on top closes (and this occurs when the boiler stops steaming) the bleeder valve on the superheater should be cracked so that steam can circulate through the superheater.

The crew that was operating the boiler when it was cooled off neglected to open the bleeder, and the crew that started to fill the boiler with water also failed to open it and neglected to watch the gage-glass and shut off the water. As a result, the boiler filled and the water pressure under the automatic valve raised it from its seat, and as the stop valve at the header leaked, the line to the boiler was under pressure. When the water got into the steam line running into the superheater, there was a water-hammer that ruptured the fitting holding the superheater pop valve.

A good rule to follow when firing up a boiler is to see that the superheater bleeder is open and allow it to blow until the boiler is on the line and generating steam with the others. W. B. CASE.

Baltimore, Md.

Regarding the question of handling superheaters during starting-up period. I have had considerable experience with both stationary and marine superheaters and in my judgment it depends altogether on the type of superheater as to whether it should be flooded or not.

One type I have operated was constructed with plain tubes, and it was just as necessary to have water in the tubes as it was to have water in the boilers, and for the same reason. This superheater was supplied with special valves and connections for flooding the tubes during the starting-up period and during any period that the boiler was cut off from the steam line. The superheater was also provided with drain valves to drain the tubes before cutting the boiler in on the steam line.

Vancouver, B. C., Canada. ARTHUR REID.

Maximum Length of Longitudinal Boiler Seams

In *Power* of Aug. 12 editorial notice is taken of some notes of mine appearing in the same issue under the caption of "Physical Tests of Boiler Steel Plates" and particularly my passing reference to certain experiences of the British Columbia Inspection Board in regard to maltreatment of steel plates used in a series of logging-engine boilers. Inasmuch as these boilers featured the continuous longitudinal lap seam (there were two seams, one on each side) it is suggested that their behavior has a bearing on the discussion now going on in *Power.*

To begin with, I may say that the seams of these vertical logging boilers measured 9 ft., which was the whole length of the shell, and beyond the fact, disclosed by one destructive explosion, that grooving under the lap was deepest midway between the plane of the furnace crown and the top of the shell, there was no allusion in the course of the subsequent inquiry by the inspection board to any influence the continuous seams might have exerted. It was obvious, of course, that the grooving had been hindered in its progress by the proximity of the furnace stays at the lower end and by the top head at the other.

The stresses set up in a boiler shell are most complex in character, being combinations of tension, compression and shear, and notwithstanding all the labors of mathematicians it is still a fact that this branch of knowledge (that is, the resistance to combined stresses —for instance, the case of combined bending and torsion, the combined hoop and longitudinal stress) is still experimentally imperfect. Then, as Dr. Urwin remarked lately, the fact that material is always calculated on its resistance to tension, whereas its real criterion of safety is its resistance to shear, inserts another disconcerting factor.

It appears that in the case of a boiler shell the great difficulty is to determine precisely where and how the actual stresses occur in the structure. For example, consider the case of a spherical boiler head. Here theory proves the strees to be only half that in the shell, from which it might be concluded that the material of the head need be only one-half the thickness of the shell. But then there is such a stress as drum tension known to be present, which constitutes an unknown factor of the elusive kind unloved by the designer. The result is that the spherical head is made the same thickness as the shell and very often $\frac{1}{16}$ in. thicker, thus exemplifying the good old engineering maxim that "The engineer is always greater than his formulas."

I am in full agreement with the view of Mr. Huston of the Lukens Steel Corporation. A riveted seam cannot be stronger than the solid plate. C. E. Stromeyer, in his "Marine Boiler Construction," deals with this question quite directly in the chapter on mechanics. "If the boiler shell is built up of several strakes and the longitudinal seams break joint it has been argued that the stresses are proportionately reduced, and that they should be calculated as follows:

$$S = \frac{pDL}{2t\Sigma(\Delta l)}$$

where P = pressure, S = stress, D = diameter in inches, L = length in inches, T = thickness of plate, $\Sigma(\Delta l)$ = the sum of the widths of the plates, including the flanged end plates, from which the rivet holes of only one longitudinal seam have been subtracted. As $\Sigma(\Delta l)$ is often greater than L, this view would lead to the conclusion that a riveted shell is stronger than a solid one. Clearly, this argument is true only as regards the mean stresses, and that it leads to valueless results is proved by the fact that the same reasoning applied to a beam would lead to a wrong conclusion, for its mean stress is just nothing, being $+ S$ at the top and $- S$ at the bottom."

The ordinary formula is the well-known $S = PD \div 2t$.

Mr. Stromeyer in the same chapter shows that the incidence of a circumferential seam in a boiler shell actually set up several stresses along a line in the solid plates that is a continuation of the central line of the joint. This he modestly figures at four times as much, although certain experiments showed the stress to be eight times greater than in the joint itself, a condition of things that could be remedied only by making the joint exactly as elastic as the plate, a considerable tax, surely, on the boilermakers' art!

In all he says about the iniquities of the lap seam of whatever length, I am in agreement with the chief inspector of the Hartford company, only I would go farther and rule it out of existence. That the shortness of the seam does not make it immune from grooving below the lap I have had proved and with a personal drenching to boot—a logging boiler again, but with circumferential seam breaking joints. The seam burst open for a distance of 20 in. from the top while undergoing the hydrostatic test. There was a heavy stay-rod bracket riveted to the shell near the seam, which by interfering with the resilience of the latter no doubt contributed to defects inherent to the lap-seam principle itself. In this case there was no question of "grain" and, as I have said, there was a circumferential seam located presumably at the right place. Yet it failed, and I am glad of the opportunity to put the fact on record if it may serve as a letter in a word of the epitaph that is slowly being composed for the longitudinal lap seam.

Quite properly I should, with some diffidence, take issue with Mr. Jeter on this question of circumferential seam as a stiffening feature in a boiler shell if the word stiffening be used as synonymous with strengthening. This admirable insurance system of which he is chief inspector has the experience of half a century to draw upon, experience varied as it is authoritative. I think, however, that the quoted argument of Mr. Stromeyer is very convincing. It is supported, too, by the new code recently compiled by the British Marine Engineering Design and Construction Committee presided over by A. E. Seaton, an engineer of international repute. In regard to boilers it reads: "It is desirable that double-ended boilers should be made with not more than three drums or strakes, the circumferential seams being as far removed from the middle length as possible." The wording here is rather ambiguous, still the meaning clearly is that the middle strake should be as wide as possible.

The photograph accompanying Mr. Jeter's article seems to indicate that the ammonia-retort shell had been held firmly by the roundabout seams while the plates intervening bulged to a very decided extent. It would be difficult, however, to conceive of the same vessel taking upon itself such grotesque features had it been subjected to internal pressure alone.

I have seen a return-tubular boiler among the remains of a sawmill—a sawmill provides an excellent fire test—with a hump on the shell close up to the circumferential seam, deforming the latter to the extent of permanently putting the boiler, solely on that account, out of commission. Speaking of a hollow cylinder, or any metallic structure for that matter, as having passed through a fire and making deductions, other than its fuse point, from its appearance is rather risky from a logical standpoint. With a prepared subject and a fire completely under control valuable information might be gleaned and an interesting experiment carried out, but with the ordinary accident fire and its attendant hose practice, it is hard to say into what capricious forms things may shape themselves.

The length of a longitudinal seam in any type of boiler need be limited only by the facilities the steel maker has for rolling sound, wide plates. No kind of longitudinal joint should be in direct contact with the fire. An empirical formula for the injurious effects accruing from any such construction might well read as varying directly as the 1 + nth power of the sum of the thicknesses of the plates compressing the joint. Contact with the fire of a clean plate, the conductivity of which is not overtaxed, does not influence appreciably the stresses on the longitudinal seam.

All that I have said in the foregoing is arguable. Engineers as a class are proverbially tenacious of an idea and rarely let go a rooted opinion without keen disputation. So it is with the men who make rules and codes governing engineering practice. They, also, are but human. I am not at all sanguine, therefore, as to this discussion clearing the air for a uniform boiler standard; the more pronounced result will rather be a reaffirmation of how doctors will continue to differ. Authorities might be quoted for and against the restrictions of the rules and the presumed modernness of the code, thus fully exemplifying the adage that even "The devil can quote Scripture for his purpose."

An editorial in *Power* of July 1, 1919, says the discrepancy is neither political nor geographical. Perhaps it is to a greater extent sentimental than anything else. An ancient community like Massachusetts, in which boilers were built at a time when these Western parts knew only the Red man, changes its practice only after due deliberation and when a certain mild prejudice in favor of its own mosaics has been overcome. There is no doubt that some of the boiler restrictions there have outlived their time and are now more conventions than an unbiased appreciation of the changed conditions. The omission of water-tube boiler mention is significant of the archaic because there is no good reason for discrimination under the otherwise general ban.

The progressed spirits at Seattle have gone, years ago, ahead of the lap-seam strictures of the A. S. M. E. Code by eliminating it altogether. A new lap-seam boiler cannot be installed in that city, neither can one be moved from its setting save to the scrap heap—or another town.

So that Seattle is surely in advance of the good Puritans of Massachusetts as well as the Academic American Society of Mechanical Engineers. That Seattle is not very far from Vancouver, B. C., may be quite another matter entirely. FREDERICK BIGGAM.

Office of Inspector of Steam Boilers.

Vancouver, B. C.

Smokeless Chimney Not Conclusive Proof of Furnace Economy

I appreciate the fact that the majority of *Power* readers are not of the type of engineers who gain their information solely by means of the monkey wrench, screwdriver and steam gage, and through mouth-to-mouth confabs, but in the issue of Sept. 2, page 401, under "Inquiries of General Interest", there is a title the "Smokeless Chimney Not Conclusive Proof of Furnace Economy."

This is not the first time that I have seen such a statement published in industrial papers and probably in the same manner, but frequently the reader and sometimes the inquirer go no farther than the title and is convinced that the body of the answer confirms the statement and believe that a smoking chimney is just the thing.

Is it not true that a smokeless chimney is tending in the right direction? Are not the vast majority of smokeless stacks indications of economically operated boiler plants? On the other hand, is a smoking stack an indication of anything but waste and inefficiency? Why limit it to boiler plants? Take any sort of stack from the common cook stove or heating stove or even fireplace if you will, up through the whole array of furnaces to the very flexible multiple-retort stoker with its great possibilities as to capacity; and other things being equal, if your reader was contemplating purchasing a plant, judging from the top of the stack and making his deductions from the mentioned article, he would probably give preference to the one making smoke and perhaps he would want it to be good dense black smoke in order to be perfectly sure that he would not be troubled with excess air.

The plant that is troubled with more than 100 per cent. excess air is usually the one ready for the scrap heap that gets its air at some other place than through the furnace, and it is the exception rather than the rule. This conclusion is arrived at after many years' experience in the combustion game in the Pittsburgh territory with its 57 varieties of furnaces.

In the most recent and up-to-date power-plant practice, with furnaces operating at the highest efficiencies possible its capabilities are limited only by the amount of air that can be properly supplied through the fuel bed.

If I were going to gamble on economical plants, I would put my bet on the clean stack every time. In this district the owners and operators are always ready to apologize for a smoking stack as a sign of waste; still we have some such stacks, but the inefficient, like the poor, are always with us.

This is not intended to criticize what was said, but the way it was said, for the writer is convinced that the policy of *Power* is for clean stacks.

Pittsburgh, Penn. W. E. PORTER,

Chief, Bureau of Smoke Regulation.

[We agree with the statement of our correspondent that the highest efficiency may be unattended by smoke, but on the other hand, there may be low efficiency when there is no smoke and therefore the title "Smokeless Chimney Not Conclusive Proof of Furnace Economy" correctly expresses that simply absence of smoke does not necessarily indicate that all other conditions for best economy are present.—Editor].

Resistance in Series in Parallel

It often becomes necessary to connect switches or other current-controlling devices in a circuit where time is essential in changing from series to parallel in order to bring about certain results. This is especially true where the apparatus used is exposed to heavy overloads and the time of their duration must necessarily be limited. Even simple arrangements of connections and apparatus sometime require not a little time and effort before the solution is found.

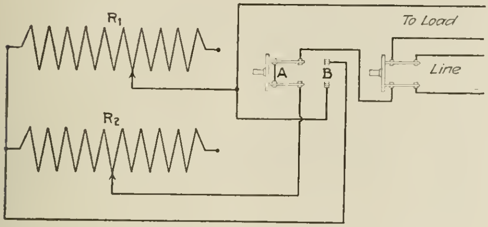


DIAGRAM OF SWITCHING SCHEME FOR CONNECTING TWO RESISTANCES IN SERIES OR PARALLEL

I once had occasion to assist in the making of a large number of tests where the time element of current duration had to be as short as possible to prevent the burning out of some of the testing apparatus. The arrangement shown in the figure was used for connecting two resistances in the circuit from series to parallel, by means of a double-pole, double-throw knife switch. When the switch is thrown to position *A*, the resistance R_1 and R_2 are connected in series, and when thrown to position *B* they are in parallel.

Greenville, Penn. C. R. BEHRINGER.

Cooling Clinkers in Boiler Rooms

In boiler rooms where there is but one fireman without an assistant the problem arises as to how the clinkers may be cooled as they are drawn from the furnaces so as to lessen the excessive heat. We have overcome this by the following method: We placed a sprinkler six inches in diameter, with a stop-cock just above each fire-door. A half-inch water-supply pipe with ten pounds pressure was placed across the front of the boilers just above the fire-door frames.

With this arrangement the man cleaning the fires can coal the ashes as fast as they are drawn, thus lessening the heat to a great extent and keeping the dust down. THOMAS J. PASCOE.

Norway, Mich.

Gas-Engine Piston Rings

On taking charge of a large gas-engined power plant, I was surprised to find that a set of piston rings lasted but six weeks in one of the engines, and I was informed that it was the usual life of a set of rings in that engine.

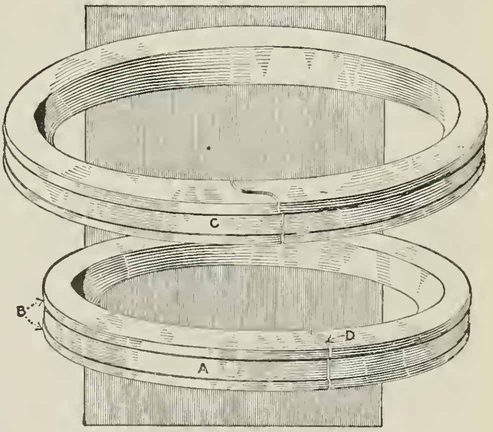
The next time the engine required new rings, an examination revealed that the cylinders were badly worn on the bottom and that there was a shoulder at each end of the ring travel such that no self-respecting piston ring could be expected to jump up and down on about one hundred and fifty times each minute for days at a time without breaking.

It was the practice to have a spare piston and rings all ready to put in the engine upon taking the old one out, and as there was some little difference in the way that the thread was started on the end of the rods, and as the rod had to be set with a certain connection at the top, it was hardly possible to get the clearance divided so that the ring travel would be the same with each piston; consequently, the ring would travel the shoulder at one end or the other of the stroke.

The shoulders were chipped out flush with the bottom of the cylinders, and the intermediate and tailrod crosshead shoes shimmed up until the pistons did not drag on the bottom of the cylinders.

The pistons carried three wide rings, which were discarded and two narrow rings placed in each groove. These changes made it possible to get from a set of rings six months' run instead of six weeks. The practice of placing the two rings in each groove was continued as long as the old pistons were good, but when new pistons were required, they were made with five narrow grooves instead of the three wide ones.

I have known pistons so equipped to run for two years, but it was in smooth straight cylinders, that were badly worn, as were those on the engine in this case. The rings were also undercut about 1-64 in. for almost the entire width, as shown at *A*. The narrow edges *B* would wear away quickly, allowing the ring to fit itself to the cylinder and the piston to get down to business in a much shorter time than if the whole width of the ring had to wear to a fit.



UNDERCUT PISTON RINGS AND JOINTS USED

The ends of the rings were originally cut to make a lap joint, as shown at *C*, but as the points would break off, the joint was changed to a square butt joint, as shown at *D*, and each ring fitted into the cylinder so that there was about $\frac{3}{32}$ in. clearance between the ends at the smallest cylinder diameter.

Cherryvale, Kan. EARL PAGETT.

Watt Centenary Celebration in England

By I. WILLIAM CHUBB

WHILE the early ties between James Watt and Greenock and Glasgow are well known, and even London can make some claims on Watt as a citizen, everyone will admit that, as the major portion of his life-work was done in or near the Birmingham district, it was appropriate that the English Midland area should be the scene of the Watt celebrations and the commemoration of the centenary of his death. The arrangements were made by general and subcommittees of Birmingham engineers, the general committee being under the chairmanship of William Mills, who will at once be connected with hand grenades, R. B. Askquith Ellis being the honorary secretary. Representatives of various universities, colleges, technical and scientific societies and institutions, besides local and other firms and local authorities, also took part in the organization of the celebration.

As a result, direct or indirect, of the war, visitors from abroad were not as numerous as the occasion might have been thought to call for, but France was represented by Monsieur A. Rateau, Sweden by Dr. Carl Benedicks and Japan by Prof. K. Takemura, while from the United States Sandford Riley and the American Ambassador, the Hon. J. W. Davis, took part in the proceedings. Professor Arentz, of Trondhjem, had, owing to an error as to date, paid a visit to England in August, and among the visitors were lineal descendants of Boulton and Watt in the persons of Miss Gertrude Boulton and Major J. M. Gibson-Watt, the British navy being officially represented by Engineer Vice-Admiral Sir G. G. Goodwin.

One effect of inquiries started by the main committee may be the correction of the generally accepted date of the death of Watt. This now seems to have been established as having taken place on Aug. 25 and not Aug. 19.

The proceedings formed an opening move in a campaign to raise funds for an international memorial to commemorate Watt, the funds to be employed as follows: "(1) To endow a professorship of engineering to be known as the James Watt chair, at the University of Birmingham, for the promotion of research in the fundamental principles underlying the production of power, and the study of the conservation of the natural sources of energy. (2) To erect a James Watt Memorial Building, to serve as a museum for collecting together examples of the work of James Watt and his contemporaries, Boulton and Murdoch, illustrating this interesting epoch in the history of engineering. The building would also serve as a meeting place and library for scientific and technical societies, and be a center from which engineers could co-operate in spreading technical knowledge. (3) To publish a memorial volume."

The writer understands that for a chair of research £30,000 to £40,000 will be required, and for the proposed building something like a quarter of a million pounds. As to the chair of research, an appeal to all the world is to be made for funds.

Following the formal inauguration of the commemoration at the Mason's College, Birmingham, by the Lord Mayor of Birmingham, on Sept. 16, an address was delivered by Prof.

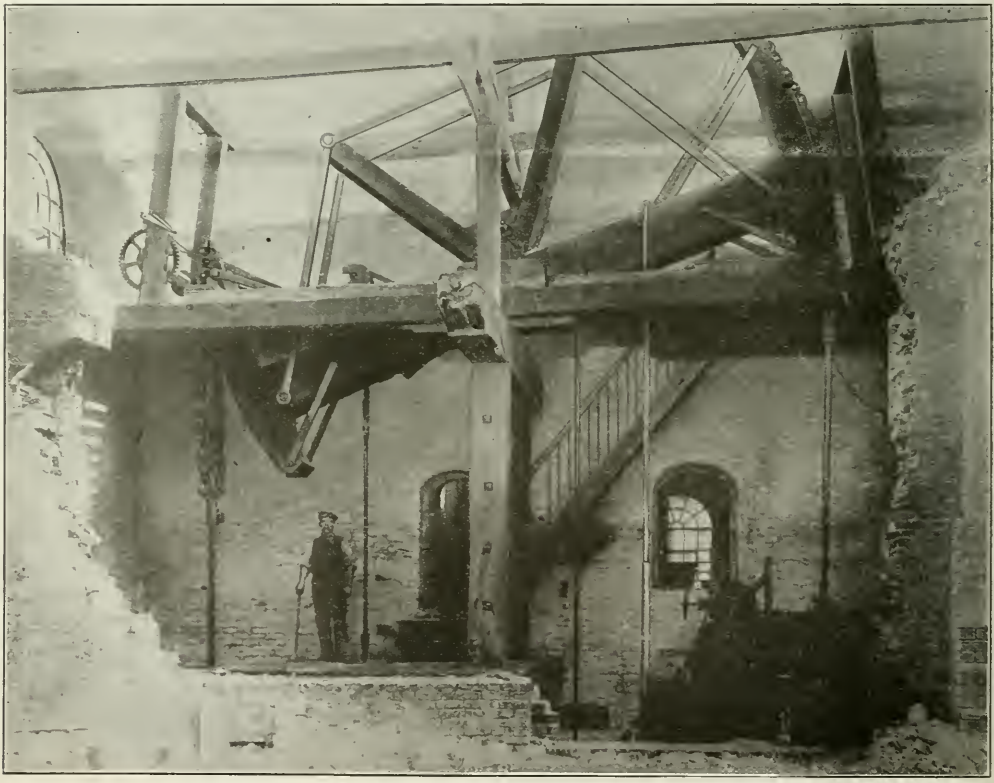


FIG. 1. OCKER HILL ENGINE BEFORE ITS REMOVAL FROM SMETHWICK.

F. W. Burstall on the rise of engineering manufacture, in which he ascribed the lack of development through the Middle Ages to lack of power rather than to any other single cause. He mentioned that in Watt's early days a great deal of small, very finely made articles were produced, but the production of large articles was impossible until the steam engine, as improved by Watt, enabled machining to be undertaken. At Soho modern engineering practice has its beginning, but its effect was not apparent in manufacturing until probably about 1870. From that time modern manufacturing, made possible by the steam engine, really developed.

On the same day in the afternoon a full choral service was held in St. Mary's Church, Handsworth, the church which Watt himself attended and where will now be found the Chantrey statue of him, together with busts of Boulton and Murdoch. The address delivered by Canon E. W. Barnes contained a review of the life of Watt, and his genius was ascribed to the combination of imagination, manual dexterity and an inherited ability for mathematics.

Later, in the afternoon at Heathfield Hall, the residence of George Tangye, a garden party was held, and, half a dozen at a time, the visitors had the opportunity of inspecting the oft-described garret workshop, which now, after a lapse of 100 years, is maintained just as when Watt left it. A proposal has been made to remove it bodily to the Watt Memorial Building when this shall come into existence.

In the evening a reception was held by the Lord Mayor of Birmingham in the Council House, and a collection of Watt, Boulton, Murdoch and other relics was displayed in the adjoining Art Galleries. The basis of the exhibition was the Boulton and Watt collection formed by the late W. H. Darlington, for twenty years manager of the Watt firm, and bought by George Tangye. This collection was presented by Mr. Tangye in 1915 to the Birmingham Municipality, and is now normally in the Reference Library, Ratcliffe Place, Birmingham. In addition articles were lent by Miss Gertrude Boulton, by Major J. M. Gibson-Watt and others.

The exhibits included a number of personal relics of Watt himself, lent by Major Gibson-Watt. But the engineer will perhaps turn more readily to the case of drawings actually executed by Watt himself, the first drawing showing the Colville engine of 1776 with steam jacket. The Chelsea Waterworks engine of 1777 is shown with plug rod for expansive working and with a load box over the force pump to cause the outstroke. A Watt drawing shows the Ales and Cakes engine of 1779, but does not include the cylinder covering. Another Watt drawing of 1784 illustrates what is understood to be the first development in that year of the parallel motion, described as "a roller working in slides above the main lever, to which is connected a single link from the crosshead." In another panel a drawing is given of the first sun and planet engine. It was supplied to Goodwyne & Co., London, in 1784.

A set of four agreements relating to sun and planet engine shows that for a 14-hp. engine supplied in 1792 the Boulton and Watt firm would receive £70 a year for 25 years by way of royalty. Then for a 12-hp. engine in Birmingham the annual sum to be paid was £60, and by an agreement of 1796 the firm received £965 for a 16-hp. engine.

As to marine work, a drawing shows the parts of the engine made by the Boulton & Watt firm for Fulton's steamboat, 1804. The boilers were made in America and a detail is given of the valve gear of the engine, while another drawing in the same collection similarly shows steam cylinders, condenser and air pump of another Boulton & Watt engine supplied to Fulton in 1811, together with a preliminary sketch of the engine. Drawings relating to a Glasgow boat, dated 1813, show a pair of engines built with the cylinders inside the boiler, for steam-jacketing purposes. Passing over earlier war vessels, steam packets, etc., we may note the drawings of a 20-hp. dredger for Hamburg in 1845, thought to be the first steam dredger built. Another drawing relates to the "Beaver," of the Hudson Bay Co., reputed to be the first steamer to cross the Pacific.

A manuscript book in Watt's handwriting deals with engines made between 1773 and 1775. An entry dated Dec. 27, 1774, states that "the wood piston being found faulty, a hat piston not oiled was put in. It was first covered with horse muck, but it being found that air pervaded it, it was covered with paper pap mixed with flour paste."

On Sept. 17 the first lecture was by Sir Oliver Lodge, on sources of energy; that is, energy due to the structure of the atom itself. If this can be utilized, he suggested, it should improve social conditions, preventing smoke due to imperfect combustion and dirt due to ashes, while the power is compact and clean; on the other hand, explosions might result from the too rapid liberation of energy.

Following this was a lecture prepared by Prof. A. Barr and Prof. J. D. Cormack, illustrated with lantern slides and descriptive of the work done by Watt with the Glasgow model of the Newcomen engine. In the course of the lecture it was claimed that Watt's inventions were due directly to the knowledge of scientific principles, not merely to chance observation.

In and around Birmingham are several Watt built engines and on the afternoons of Sept. 17 and 18 visits were paid to three of these. The engine now at Ocker Hill, near Tipton, was originally at Smethwick, being built by Boulton & Watt in 1776 for the Birmingham Canal Navigation Co. Consequently, it is the earliest pumping engine in existence built for sale by the firm. The steam cylinder is 32 in. in diameter with a stroke of 8 ft., though as running at the time of the visit the stroke was, we believe, 6 ft., and the pressure was given as 15 lb. absolute. The water pumped per stroke was 223 gallons. The engine is installed in its own house and is without steam, which was supplied from a launch on the adjoining canal. Running, it made 14 strokes a minute, and indicator diagrams were taken by Prof. F. W. Burstall with an original James Watt indicator. The engine worked regularly until 1892, when it was taken down, removed and re-erected. The chain is usually in tension, but the links are closed somewhat to avoid the effect likely to result from compressive action. The beam bears a pendulum-type counter. It may be mentioned that the 2-in. bolts used for fastening have threads that were cut by chisel and file. The illustration shows this engine in position at Smethwick, where the lift was about 21 ft.

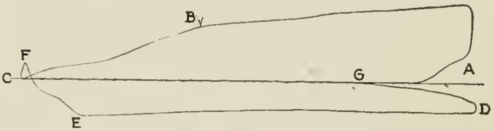


FIG. 2. DIAGRAM FROM OCKER HILL ENGINE.

One of the indicator cards taken at the time of the visit is reproduced in Fig. 2. This engine worked only on the downstroke, the upstroke or "out" stroke, as it was sometimes called, being accomplished by the weight of the pump rods and plungers. At the beginning of the working stroke, steam was admitted above the piston while the bottom of the cylinder was connected to the condenser. When the stroke was partly finished, cutoff occurred and the steam worked by expansion. Later, the exhaust valve was closed, and at the end of the stroke an "equilibrium" valve connecting the two ends of the cylinder was opened. This equalized the pressure above and below the piston and allowed it to rise. Near the end of the upstroke the equilibrium valve closed, giving a cushion or compression in the top of the cylinder, the exhaust valve opened, and at the end of the stroke admission occurred again and the cycle was repeated.

Referring now to the card, the upper portion is taken from the top of the cylinder and the lower portion from the bottom. Admission occurs at *A* and cutoff at *B*, giving expansion from *B* to *C*. At the same time the lower end of the cylinder is exhausting as shown from *D* to *E*. At the latter point the exhaust valve closes and the pressure rises due to compression to *F* when the "equilibrium" valve opens and the pressure equalizes in the two ends. The line from *C* to *G*, which in this card coincides with the atmospheric line, represents the transfer of steam from above to below the piston at constant pressure, while the piston rises. At *G* the exhaust valve opens and the equilibrium valve begins to close. The cards were taken with a 15.4-lb. spring.

Under its original conditions the pump had a lift of 21 ft., while these cards were taken under a lift of only 3 ft. Weights were hung on the pump end of the beam to give the engine more load. The piston was leaking badly at this time, so that the vacuum shown on the cards was much less than normal.

The engine at Bowyer Street, Bordesley, was built in 1795 and ran regularly until 1884. The steam cylinder is given as 46 in. diameter by 8 ft. stroke and the pump of 32 in. diameter, and drawings giving details of the valve gears were among the collections in the Art Gallery. Two wagon-shaped boilers were originally employed, and the steam pressure was about 2½ lb. that is, the engine was practically atmospheric. In fact, one of the means taken to present boiler leakage was to employ at the joint a stuffing of firewood, knocked in. On top of the engine cylinder head was a depression in which Russian tallow was melted for cylinder-lubrication purposes, and examples of the gasket, links, pins, etc., are collected in the engine house. One feature is that the beam has its center of gravity below the axis of suspension. This engine has been standing since 1884, having been rediscovered by Dr. J. R. Ratcliffe, who acted as guide. It has hardly a new part on it, although subsequent to its first condition the beam has been fitted with a top strut bracket and three chains are attached, whereas the original drawing shows but two. The relics here include an old Watt lathe sent out with the engine for the purpose of effecting repairs, the original James Watt spanners for the nuts on the beam, etc.

The remaining engine, at Lawley Street, Birmingham, has been running since 1819, being used in connection with canal locks. Even now it does, as required, its ten hours a day. The cylinder is 36 in. diameter by 7 ft. stroke, and the pressure 10 lb. or less, the strokes made being 12 per minute, the lift 46 ft. and the power roughly 36 hp. Of the saddleback boilers originally installed, one is at present used to hold rainwater, and the steam is supplied from a Cornish boiler.

On the morning of Sept. 18 a visit was made to the works of W. & T. Avery, Ltd., Soho, who in 1895 took over the place from James Watt & Co. The Soho Foundry was built in 1796 by Boulton & Watt as an extension of the original Soho factory, which was a mile or so distant, and its purpose was to manufacture and finish heavier machinery. James Watt & Co. succeeded Boulton & Watt after the death of James Watt, Jr. Visitors saw the original entrance place, including, too, a clock that has been running since 1812, and a row of houses for work people built in 1796, in one of which Murdoch lived down to 1817. What is often stated to be the original gasometer, the first of its kind, was also shown. Certainly it is the site of the first, although the original drawings, the writer thinks, show a square gasometer, whereas the present is circular. Copper pipes which conveyed the gas to Murdoch's house, almost a mile away, have been found in the course of excavation. Part of the original workshop remains. The engine-erecting shop, in which were built, for example, the engines of the "Great Western" and also the engines for the Fulton steamship, is still employed, though now chiefly occupied with the erection of testing machinery. Some machine tools remain that date from the early ages of mechanical engineering; for instance, a wall planer known to be 120 years old and thought to be the first of its kind. There is also a faceplate lathe that has been running for some 90 years, having been removed from the Soho factory when those works were closed in 1850.

On the same day at noon a degree congregation of the University of Birmingham was held in the Birmingham and Midland Institute, where honorary degrees were conferred on the United States Ambassador, Prof. A. Rateau, Prof. Barr, Sir G. Beilby, F. W. Lanchester, and others.

On Friday, Sept. 19, visits were made to local engineering works, and the final item in the series of functions consisted of a procession in the afternoon of Saturday, Sept. 20, from near the center of the city to the Botanical Gardens, Edgbaston, where a fête was held. In addition to concerts, lectures were delivered on Watt and the significance of his invention. In the procession was a half-sized model made by a number of local engineering firms of the Watt lap engine. Engines and pumps, drilling machines, weighing machines, motor cars and tractors, electrical machinery, etc., were also in the procession, with deputations from the various engineering trade unions, this part of the program having, in fact, been organized by trade unionists themselves.

Electricity Supply in England During the War

A paper on "Electricity Supply During the War," by A. B. Gridley and A. H. Human, published in the "Journal of the Institute of Electrical Engineers," England, gives a summary of the power-plant expansion in England during the war. Power stations supplying railways or tramways only and private plants are not included.

One hundred and three municipal and 33 company-owned power stations were extended or built. The plant capacity of 327 municipal undertakings increased from 705,000 kw. installed at June, 1914, to 1,490,000 kw. installed or on order at Oct. 31, 1918. Similarly, some 230 company-owned power stations expanded from 430,000 kw. to 788,000 kw. The additional generating-plant capacity installed or ordered during the war therefore aggregated 1,143,000 kw., which is almost exactly equal to the total plant capacity existing when the war broke out.

The capital outlay involved on these extensions, with additions to main stations and substations, was approximately £23,000,000. Before the war the average size of generating units installed was 522 kw. and the largest unit in operation was of 8000 kw. capacity. The average size of units on order Oct. 31, 1918, was 7044 kw., and units of 25,000 kw. and 30,000 kw. were being built. The kilowatt-hours sold during the year ended June 30, 1914, were 2,100,000,000. For the year ended Dec. 31, 1917, there were 3,520,000,000. It can be assumed that the output for 1918 was nearly double that of 1914. The coal consumption per unit sold in 1914 was 4.1 lb. In spite of the very inferior fuel used in 1918 in comparison with 1914, the coal consumption in 1918 fell to 3.75 lb. In 1918 the coal consumption in municipal stations was 4.17 lb. per unit, and in company stations 3.17 lb. In 1918 the load factor of all the municipal stations combined was 28 per cent, and of all the company stations, 33 per cent. The load factor of individual stations varied widely. On Dec. 31, 1918, the municipalities had 237,000 kw. of load awaiting connection and the companies, 121,000 kw. The kilowatt-hours obtained other than by coal-firing were: Oil fuel, 50,000,000; waste heat and gas, 215,000,000; water power, 23,000,000.

A Method of Checking the Alignment of Diesel-Engine Shafts*

By George E. Windeler

It being generally conceded that the alignment of an engine, and especially of the shaft, is a most important factor in satisfactory operation, a simple method of checking this alignment is desirable. This checking should be applied from time to time after the engine is operating and therefore the method proposed should be easily applied without dismantling the engine.

The crankshaft, formed as it is with large intermittent gaps, is a comparatively weak structure, and great care must be used not to strain it in handling during erection. After making sure that the bearing shells are accurately bedded, the shaft should be tested in its bearings for concentricity and roundness of its journals. After any errors are found and corrected, the gaps may be put on and the shaft is ready for operation. This is, of course, the proper method when the engine is being erected.

When the engine has been running for some time and an overhaul is being considered, questions to ask with regard to the crankshaft are: Is it being properly supported in its bearing? Are the bearings in a satisfactory condition? Are all the bearings, including the outboard bearings, in alignment with one another?

The first indication that the shaft is not being properly supported is excessive end play on the shaft with the flywheel running out of true. Since this end play often exceeds the thrust-collar clearance, it must be due to springing of the crankshaft for want of support, thus extending and contracting the shaft by opening and closing the gap between the crank webs. Quite interesting results were obtained by measuring this gap when the given crank was on the top and then on the bottom center. If the bearing next the crank was low, the crank webs would close when the pin was on the bottom center and open when it was on the top center. If the outboard bearing was low, the weight of the flywheel would give the opposite effect. It can be determined from such measurements which bearing or bearings are low and approximately how much since in general the amount will be nearly equal to the difference in the readings at the top and bottom centers respectively.

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*Abstract of a paper and discussion read before the Diesel Engine Users' Association, London.

The use of an inside micrometer for these measurements was found to require very skillful handling, but a point gage and feelers proved much more satisfactory. It is of course necessary to take repeated measurements from between the same points. This can be accomplished by making a slight indentation in the crack web to locate the point of the gage.

The question arose as to how much more the crankshaft would be distorted under operating pressures than when standing still. It was suggested that the full blast pressure be applied when measuring the crank web with the crank on the top center. This was objected to as dangerous to the man making the measurements.

Some objection was made to depending entirely on gaging between crank webs as a criterion for crankshaft-bearing alignment. It was claimed that this method would not accurately indicate eccentricity of journals. Also a great difference in web measurements is shown when taken with or without the flywheel in position. Further, a bearing seldom wears equally throughout its length. In this case the shaft will rest only on the high end and perhaps show very little change in web distance unless the gaging is done under full working pressure. Another objection was the difficulty of interpreting the readings when made on an intermediate crank, this objection of course having no standing when applied to outer bearings.

Large Gas Engines in German Iron and Steel Works*

By Cosmo Johns and Lawrence Ennis†

The report is a statement of facts and inference based on observations made in the occupied territories on the left bank of the Rhine. Regarding power, nothing was more suggestive or instructive than the use made of large gas engines. Blowing engines for the blast furnaces and for bessemer converters, and electric power generators were nearly always gas-driven.

In blast furnaces a large amount of fuel gas is generated as a byproduct. After being cleaned, this gas is used as fuel for heating the air which is blown to the furnaces and converters, and for the generation of power. In the case of power the gas may be used in internal-combustion engines. The over-all efficiency from fuel to power is greatly in favor of gas engines, and the number of large units installed in nearly every plant was a proof of their reliability.

The gas engines, ranging from 1500 to 5000 hp., were used as blowing engines, both for blast furnaces and for converters, and to drive generators. For the latter use they did not respond well to the fluctuating demands, and the usual practice was to install some steam-turbine-driven generators to assist the gas-driven generators, although the gas engine was the predominant partner.

As a further refinement, at the Volkingen works in the Saar Valley, a waste-heat boiler has been installed to utilize the heat of the exhaust gases of a 3000-hp. gas engine. This has been so successful that a second boiler installation is under way. It is suggested that the cooling water from the gas engine be used as feed for the waste-heat boiler.

The more the gas engine can be used for power and blast production the less will be the fuel consumption, from ore to finished steel, per ton of product, as there will be more gas available for furnace heating.

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*Abstracted from a "Report on the Present Status of Fuel Economy in the German Iron and Steel Industry of the Occupied Territory on the Left Bank of the Rhine," read before the Iron and Steel Institute at the autumn meeting in September, 1919.

†Members of a commission appointed by the British government to investigate the German iron and steel industry in the occupied territory.

Spasmodic Safety Efforts and the Harmful Results

By H. M. Webber†

The experienced "Safety" man knows that no good can come of occasional efforts at accident prevention. The important results obtained by the National Safety Council, the railroads and the various industries, have been possible only because of the constant and persistent efforts put forth.

When a brilliant start is made and then nothing done for months, the effect is about as successful as if the Allies had made only occasional efforts to stop the German armies.

In addition to the purely negative effect of no results, an intermittent safety campaign has positive harmful results. A well-presented accident prevention program will usually meet with response from workmen, because it is easy to show them that they have a vital interest in it. If, however, the employer drops the matter after a short time, the employees become disgusted and it is much harder to arouse their interest a second time. Safety work is principally a fight against bad habits, which are easy to form and hard to break, and in favor of good habits that are hard to form and easy to break. A habit once broken and then returned to is harder to break a second time.

It is not necessary to emphasize the importance of safety work. It is, however, very important to emphasize the necessity for its unbroken intensive continuation. Better no safety work at all than spasmodic safety work.

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†Superintendent, Department of Claims, Chicago Telephone Co., Chicago.

*Abstract of paper read before the Eighth Annual Safety Congress of the National Safety Council, October, 1919.

Move to Nationalize Germany's Power Supply

A bill nationalizing the electric power of the German Empire is reported to be pending. Germany has over 4000 power establishments, and the splitting up of their activities is held to cause serious waste. The scheme is made imperative by the loss of the Saar coal fields and the obligation to supply coal to the Allies.

The water power, which is mostly to be found in South Germany, is primarily to serve local industries, but an agreement will be made with those generating electricity from coal in central Germany. Power stations belonging to states and municipalities would not be disturbed, but the large plants belonging to private capital would be taken over and nationalized by the central Government. According to the plan the Government would buy up shares, so that the present organizations can remain intact. The nationalized works are not to be considered as a source of revenue, as the government holds that cheap power for industry is more important than fiscal interest.

The private capital in electrical power works in Germany is estimated at one billion marks and the use of electrical power in that country has increased from 4.43 billion kilowatt hours in 1907 to 22 billions in 1917.

Fuel Oil in New York City

New York City fuel oil rules governing storage and use of fuel oils, and construction and installation of oil-burning equipment, have been adopted by the Board of Standards and Appeals of New York City, and such oils can now be used in buildings of the city in place of coal. A tentative draft of proposed rules governing storage and use of fuel oils and construction and installation of oil-burning equipment was drawn up during the summer, and after a number of public hearings amendments to the draft were submitted to fuel oil engineers and fire-prevention experts for their opinions. The rules were promulgated Nov. 11 and become effective Dec. 1, 1919. Persons desiring to make installations under these rules may obtain copies of them upon request at the office of the Board of Standards and Appeals, Municipal Building.

Plans for installations under the new rules can be filed with the Bureau of Fire Prevention, and permits can be obtained immediately for the necessary work and alterations required for installation of oil-burning equipment.

Interprofessional Conference to Be Held at Detroit

With the purpose of bringing together the professional men of the country in order to plan more effective relations and to act together on matters pertaining to the public good, an Interprofessional Conference is being called to meet at the Statler in Detroit, Nov. 28 and 29. The conference was suggested by the Post-War Committee of the American Institute of Architects, which was established to study the new obligations thrust upon the architectural profession by the war.

It is the hope of those fostering the movement to perpetuate to an appreciable degree the enthusiasm of the war-time service rendered to the public by the professional men of the nation. The subjects which might well come before such an interprofessional organization have been classified under three heads: (a) The Functions and Interrelations of Professional Organizations; (b) Relations of Professions to the Public; (c) Educational Obligations of the Professions.

The Detroit program provides for an opening session in which representatives of the various professions will give their views as to the desirable objects, scope, method of procedure and organization for an interprofessional body. Following this discussion, which will be opened by Thomas R. Kimball, president of the American Institute of Architects, the plan is to appoint a committee on plan and scope which will be asked to report on the succeeding day when, if necessary, both sessions will be devoted to a discussion of the committee's report and to the permanent organization of whatever type of body may be agreed upon.

To date, among others, representatives of the medical, legal, educational and construction professions have accepted membership on the organizing committee. It includes Dr. Alexander Lambert, president of the American Medical Association, New York; Thomas R. Kimball, president of the American Institute of Architects, Omaha; Calvin W. Rice, secretary of the American Society of Mechanical Engineers, New York; Frederick L. Ackerman, New York; Felix Adler, New York; Charles A. Beard, New York; Charles A. Boston, New York; N. Max Dunning, Chicago; Henry W. Hodge, New York; Robert D. Kohn, New York; Arthur D. Little, Cambridge, Mass.; Basil M. Manly, Washington; Milton B. Medary, Jr., Philadelphia; George A. McKean, Detroit; E. J. Mehren, New York; Frank A. Waugh, Amherst; and Charles H. Whitaker, Washington.

The office of the organizing committee of the Interprofessional Conference is at 56 West 45th St., New York City.

Engineering Section, National Safety Council

The Executive Committee of the National Safety Council, in acordance with the action of the Council at its annual meeting, Oct. 1, has approved the organization of an engineering section, the purpose of which shall be to bring together the civil, mechanical, electrical, mining and chemical engineers in the Council's membership, so that they may contribute more effectively toward the solution of the purely engineering problems encountered in safety work.

Persons applying for membership in the Engineering Section must be members of one of the five great national engineering societies or Canadian or European societies of equal standing or must have had at least ten year's experience in engineering work, including at least five years in responsible charge, a college degree being considered equivalent to two years' experience. For associate membership three years' experience is required; this will gradually be increased to six years.

The functions of the engineering section are stated as follows: (1) To help meet the technical demands of the various industrial sections and furnish them technical information as desired. (2) To perform technical services for the Council, on request of the Executive Committee, such as the developments of standards or participation therein; the solution, by inquiry or through research, of special engineering problems arising in safety work, and helpful coöperation with the American Engineering Standards Committee, the National Engineering Societies, the Bureau of Standards, the casual departments of underwriters' laboratories, etc. (3) To conduct one or more meetings as a part of the Annual Safety Congress, at which engineering problems shall be discussed. (4) To conduct, if considered desirable, one or more additional sectional meetings during the year or in different localities. (5) To carry on such other activities as will, in the opinion of the Executive Committee of the National Safety Council, promote the safety movement and the best interests of the Council.

Two Thousand New Members for W. S. E. in One Week

From Oct. 4 to 10 inclusive the Western Society of Engineers conducted an intensive drive for new members. The goal was 2000 new members in a week, and almost exactly that number was added to the roll. A campaign organization consisting of an executive committee and fifteen teams of ten men each, directed by F. C. Barber, a professional organizer, was responsible for the results. Chicago engineers, architects, chemists, public-utility officials and a few business men interested in engineering are included in the list.

War experience had emphasized the need of coöperation among engineers and the value of one big local association that would link all engineers together for effective work, effective not only in numbers but in influence on local engineering affairs and in the upbuilding of the profession. The Western Society is now the big local association that was desired. There are progressive plans for the future in which local team work will count, and one of the first and biggest is an adequate engineering building for Chicago. A more active participation in civic affairs involving engineering, definite action in professional and welfare problems, more extended coöperation with national and other local societies, group courses in specific subjects, expansion of the engineering library, are some of the plans of the board of directors to benefit the members and to maintain their interest, to increase the prestige and standing of engineers in Chicago and by so doing elevate the profession to a higher plane of usefulness and service. It is a worthy work well started, and developments should prove of exceptional value to other cities planning a similar movement.

Fuel-Oil Stations for American Ships

The United States possesses a fleet of 486 oil-burning steel steamships representing 3,798,733 deadweight tons of new construction. In addition there are 49 freighters of the oil-burning type which have been reconveyed by the Shipping Board to their American owners and still another group of 18 which have been sold by the board and which are under the American flag. Of the 720 steel vessels under construction and contracted for, 636 are oil burners, these aggregating 4,691,659 deadweight tons. When the steel program has been completed, there will be a total of 1731 of the oil-burning type under the American flag.

American steamships can soon make a circuit of the world without the need of taking fuel at other than American-owned fuel stations. This applies to vessels steaming east from the Atlantic Coast or west from the Pacific seaboard.

The task was to find suitable places for the establishment of fuel stations along the trade lanes or adjacent to them. At the Panama Canal, the turn at the world's crossroads, facilities already existed and only required to be amplified. To take care of the east coast trade of South America, a station was erected at St. Thomas. This station, which had an initial capacity of 15,000 tons of storage, was opened on Oct. 2. Arrangements have been made for establishing a station at the Azores and another at Bizerta, a small French island off Tunis and located on the ocean-highway to the Indies. Material has been assembled at Manila, where another large storage tank is to be erected.

The total requirements for the United States merchant marine in 1919 have been estimated at 31,000,000 barrels.

Personals

E. Cort Magens, formerly with H. Belfield Co., is now director of sales with Pratt & Cody Co., Hartford, Conn.

E. J. Bell has been elected secretary and treasurer of the Frederick Engineering Co., Frederick, Md.

O. J. Gasche has been appointed manager of the Chicago branch office of the Springfield Boiler Co., 651 Marquette Building.

The F. H. Niles & Co., Inc., announces the appointment of F. H. Crawford as secretary and J. E. Haetten as sales manager of the company.

F. W. Leahy has resigned from the Emergency Fleet Corp. to assume charge of the marine department of the Diamond Power Specialty Co., Detroit, Mich.

Louis H. Egan, who was assistant general manager of the Union Electric Light & Power Co., St. Louis, Mo., has been elected one of its vice presidents.

C. W. Cross has been appointed by the Chicago Pneumatic Tool Co. as manager of western railroad sales, with headquarters at Fisher Building, Chicago.

F. R. Wadleigh has become associated with the Weston Dodson & Co., Inc., Dodson International Coal Corp., New York City, as consulting and expert engineer.

Harry T. Calkins is a new addition to the sales force of the Tacony Steel Co. He will be attached to the New York office but will sell in Connecticut exclusively.

G. P. Goodman, who for several years has represented the Hisey-Wolf Machine Co. in the East, went with F. H. Niles & Co., Inc., on Oct. 1, to take charge of its portable tool department.

W. A. Riddell has been elected president of the newly incorporated firm of the Frederick Engineering Co., Frederick, Md. Mr. Riddell is also president of the Frederick (Md.) Iron & Steel Co.

Harold P. Childs, formerly with the Westinghouse Machine Co., East Pittsburgh, Pa., is now vice-president and manager of sales of the Frederick Engineering Co., Frederick, Md.

Harry William Waterfall and Paul James Kiefer have been appointed assistant professors of mechanical engineering and steam engineering respectively in the College of Engineering of the University of Illinois.

F. L. Converse, formerly plant engineer of the Tacony Ordnance Corp., at Philadelphia, is now connected with the engineering department of E. I. Du Pont de Nemours & Co., at Wilmington (Del.) office.

C. F. Herington, formerly mechanical engineer of the Bonnot Co., Canton, Ohio, is now district manager of the Chicago office of the same company with office at Room 882, Continental & Commercial National Bank Building.

S. J. Andres has resigned as electrical engineer of the Kellogg Toasted Corn Flake Co., Battle Creek, Mich., to connect with some progressive coal company or open an office of his own. He is now at Prescott, Ark.

F. G. Rogers has been appointed manager of the Chicago office of the Under-Feed Stoker Co. of America in place of F. M. Smith, resigned. Mr. Rogers has been attached to the Chicago office in the capacity of sales engineer since 1916 and will be located at the present office of the company, 521-523 Harris Trust Building.

Edwin Lundgren, who was formerly chief engineer of the stoker department of the Westinghouse Machine Co., and consulting engineer of the Westinghouse Electric and Manufacturing Co., is now vice-president and chief engineer of the newly incorporated firm of the Frederick Engineering Co., Frederick, Md.

H. W. Price, of Frostburg, has succeeded V. St. C. Montieth as the Martinsburg (W. Va.) manager of the Potomac Power Co. Mr. Price was formerly connected with the Frostburg Illuminating and Manufacturing Co., and the Edison Lighting Co., of Cumberland. Prior to that he was with the W. L. Doherty Co. Mr. Montieth has been promoted to a superintendency of the various plants of the company and will make his headquarters in Hagerstown.

Wm. L. DeBaufre has been appointed professor of mechanical engineering at the University of Nebraska, resigning the position of designing engineer of the Precision Instrument Co. of Detroit. He will still act as consulting engineer for this firm and others on development and research problems in engineering and industrial measurements and processes. Prof. DeBaufre was mechanical and electrical engineer for over seven years at the U. S. Naval Engineering Experiment Station, Annapolis, Md., where he had charge of important investigations on fuels, power plant and refrigerating machinery, and engineering instruments. He is the inventor of the regenerative evaporator system and the orifice method of operating evaporators controlled by the Griscom-Russell Co. of New York.

Engineering Affairs

The American Society of Mechanical Engineers announces the following Section meetings: Atlanta, Ga., Nov. 25; Cleveland, Ohio, Nov. 25, in the rooms of the Cleveland Engineering Society, Roof Garden, Hotel Statler.

The Associated Manufacturers of Water Purifying Equipment, organized during the war, has become a permanent organization. Its work will consist largely of standardization of equipment sizes, of guarantees to customers and of terms of sales. The first meeting of the association to be held in the West, will be held at the Hotel Fontenelle, Omaha, Neb., Nov. 17.

The American Society of Mechanical Engineers will hold its fortieth annual meeting at the Engineering Societies Building, 29 West 39th St., New York City, Dec. 2-5. The following is a partial list of the papers to be presented: "Common Errors in Designing and Machining Bearings," by C. H. Bierbaum; "Turbo-Compressor Calculations," by A. H. Blaisdell; "A Perfected High-Pressure Rotary Compressor," by C. B. Lord; "Modern Electric Furnace Practice as Related to Foundries," by W. E. Moore; "Scientific Development of the Steam Locomotive," by John E. Muhfeld; "An Investigation of Strains in the Rolling of Metal," by Alfred Musso; "A New Type of Hydraulic-Turbine Runner," by Forrest Nagler; "Appraisal and Valuation Methods," by David H. Ray; "Kerosene as a Fuel on High-Speed Engines," by L. F. Seaton; "Oil Pipe Lines," by S. A. Sulentic; "Lubrication of Ball Bearings," by H. R. Trotter; "Thread Forms for Worms and Hobs," by B. F. Waterman; "Octaval Notation and the Measurement of the Binary Inch Fractions," by Alfred Watkins; "Motor Transport Vehicles for the U. S. Army," by John Younger; "Air Pumps for Condensing Equipment," by F. R. Wheeler.

The American Association of Engineers, executive committee, has rendered a decision that the constitution of the association does not prohibit the admission of architects, and announces that the applications of architects will be considered hereafter in the same status as applications from engineers. Those architects who have previously applied for membership and whose applications could not be accepted on account of the apparent exclusion of architects by the constitution, may now re-enter their applications for membership.

The association announces the appointment of the following chairmen of national committees for the ensuing year: Amercanization, Garrison Babcock, consulting telephone engineer, Chicago; Education, Prof. Frederic Bass of the University of Minnesota, Minneapolis; Ethics, Isham Randolph, consulting engineer, Chicago; Finance, Glen Vivian, Accounting Department, Bureau of Statistics, Chicago, Milwaukee and St. Paul R. R., Chicago; Highway, R. C. Yeoman, chief engineer, Indiana Sand and Gravel Association, Indianapolis; Legislation, W. H. Whipple, chief engineer, Lime Association, Washington, D. C.; Membership, R. W. Barnes, principal assistant engineer, Southern Pacific Ry., Portland, Oregon; Municipal Engineering, S. C. Hadden, editor of Municipal and County Engineering, Chicago; Practice, H. W. Clausen, general office manager, C. D. Osborne Co., Chicago; Program, L. Winship, assistant engineer, Missouri Pacific R. R. Co., St. Louis, Mo.; Public Relations, L. K. Sherman, president of the United States Housing Corp., Washington, D. C.; Publications and Publicity, W. W. Horner, chief engineer, City of St. Louis; Qualification, A. C. Irwin, engineer, Structural Bureau, Portland Cement Association, Chicago; Salaries of Engineers in Public Service, A. N. Johnson, consulting highway engineer, Portland Cement Association, Chicago.

Business Items

Reeds and Thorpe, power engineers, have been organized with offices at 904 Main St., Hartford, Conn.

The United Electric Construction Co., **Inc.**, has opened a branch office at 558-559 Hippodrome Annex, Cleveland, Ohio.

The Sanford Riley Stoker Co. announces the appointment of M. G. Brennan as district engineer in the Western territory and W. Mather as district engineer in the East.

The Poole Engineering & Machine Co. Baltimore, Md., has opened a branch office in the Old South Building, Boston, Mass., with Robert W. Catlin as district manager.

Starkweather & Broadhurst, Inc., Boston, Mass., has opened an office in the Third National Bank Building, Springfield Mass., with W. P. Alexander, formerly of the Providence Engineering Works, in charge.

The Baber-Greene Co., Aurora, Ill., recently began work on the construction of a 180 x 90 ft. addition to its factory. This is the second time this year that additions have proved necessary in keeping up with orders. The new building will be used as the assembly department and will be modern throughout.

The Montrose Metal Roofing Co., of Camden, N. J., has been purchased by M Sheffler and Samuel Gross, of Philadelphia, the former being president and the latter treasurer of the company. They have also started another company under the name of Montrose Metal Products Co., to do a general metal stamping business at Camden.

Parsons-Moorehead Machinery Co., Hostetter Building, 237 Fourth Ave., Pittsburgh, Penn., has been organized to do a general machinery business. Mr. William L. Moorhead of this company was formerly vice-president of the Duquesne Electric & Manufacturing Co., while Mr. Parsons has been doing a general machinery business for several years. Both men are well known in the trade.

Trade Catalogs

The Medart Patent Pulley Co., Inc., St Louis, Mo., has issued a 16-page booklet illustrating and describing Medart friction clutches. A copy may be had free upon application.

The Barber-Greene Co., Aurora, Ill., has published a 32-page catalog, No. 3, on B-G Standardized Belt Conveyors. This catalog fully describes and illustrates the company's standardized material handling machines, portable and stationary belt conveyors and self feeding bucket loaders. A copy may be had free upon request.

The Metal & Thermit Corp., New York City, has issued a folder entitled "How Thermit Cured my Diseased Neck," which illustrates a thermit welding repair, consisting of building up with thermit steel the worn pods on the end of the 16 inch diameter neck of a large roughing mill pinion.

Lea-Courtenay Co., Newark, N. J., has recently issued two new bulletins—one, termed H-4, is a treatise on centrifugal pumps as well as a catalog of the company's most complete line. The other bulletin, S-5, is a synopsis of typical centrifugal pumps installed in various industries, showing the wide range of pumping service which Lea-Courtenay centrifugal pumps cover. A copy of either of these bulletins may be had on application to the company.

The Heine Safety Boiler Co., St. Louis Mo., has recently completed the printing of "Marine Boiler Logic," a 69-page booklet dealing with the fundamental design of marine cargo carriers. The booklet was written by Chas. H. Stoddard, consulting marine engineer of the Heine Company The main part of it relates to the design and construction of Scotch and water tube boilers for marine purposes. Evaporative capacities are worked out for the two types, using coal or oil as fuel, with natural or forced draft. It also contains a discussion of power and speed of cargo vessels. The last part of the booklet is devoted to a description of the construction and operation of the cross-drum type of water tube boiler developed by the Heine Company for marine service.

New Construction

PROPOSED WORK

Mass., Springfield—The United Manufacturing Co., 57 Willow St., will construct a 1 story addition to its present machine shop, also a 1 story boiler house, on Bernie Ave. Estimated cost, $25,000. Work will be done by day labor.

N. Y., Auburn—McIntosh & Seymour, 91 Orchard St., are in the market for pumps for marine boilers.

N. Y., Norwich—Tooker & Marsh, Arch., 101 Park Ave., New York City, will receive bids about January 2 for the construction of a grade and high school, for the Board of Education. A steam heating system will be installed in same. Total estimated cost, $250,000.

Pa., Altoona—The Board of Directors authorized C. M. Piper, Secy. of the Board of Education, to engage engineers to draw up plans for a plant to furnish light, heat and power to Altoona High, Central, Grammar and Emerson Schools. The plant is to supply power to the buildings located within a radius of the city block. Total estimated cost, $100,000.

Pa., Philadelphia—The Sun Shipbuilding Co., Finance Bldg., 1426 Penn. Sq., is in the market for 200-250 h.p. locomotive type boilers.

Va., Norfolk—Fenorstein & Co. is having plans prepared by R. E. Mitchell & Co., Arch., Flatiron Bldg., for the construction of a 5 story, 180 x 250 ft. ice and cold storage building.

N. C., Garland—The White Lake Lumber Co. is in the market for a feed water heater for an 825 h.p. boiler.

Fla., Vero—The Vero Utilities Co plans to install a 75 h.p. engine and generator in its electric light plant here. Electric lines will also be extended.

Ohio, Cleveland—The Capital Amusement Co. will receive bids about December 15 for the construction of a 2 story, 100 x 160 ft. motion picture theatre on East 117th St. and Kinsman Rd. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—The City Ice Delivery Co. will soon award the contract for the construction of a 1 story 28 x 70 ft. ice storage building and a 1 story, 22 x 24 ft. engine room, at Station 4, Madison Ave. Total estimated cost, $25,000. Harry I. Norvall, Cadillac Bldg., Pres. C. C. Coneby, Cadillac Bldg., Arch. and Engr.

Ohio, Elyria—The city will receive bids in December for building a complete waterworks system, including 1,000,000 gallon pump, two 300 h.p. boilers, filter house and 9 mi. of 60 in. water main. Total estimated cost, $1,000,000. Morris Knowles, Jones Law Bldg., Pittsburgh, Penn., Engr. Noted Sept. 30.

Ohio, Lakewood—W. R. Powell, Arch. and Engr., Rose Bldg., Cleveland, will receive bids about December 18 for the construction of a 1 story, 80 x 240 ft. market house on Detroit Ave., for the Lakewood Market House Co., c/o architects. A steam heating system will be installed in same. Total estimated cost, $250,000.

Mich., Jackson—The Hup Motor Co. plans to build a 1 story, 60 x 90 ft. power house, to include 2 vertical type boilers, engine, fan, pumps, etc. Smith, Hinchman & Grylls, 710 Washington Arcade, Detroit, Arch. and Engr.

Ill., Oak Park—The Board of Education will soon award the contract for the construction of a 4 story, 144 x 157 ft. high school. Project will include an addition to the present heating plant in the old building. Total estimated cost, $150,000. Holmes & Flinn, 8 South Dearborn St., Chicago, Arch.

Wis., Colfax—J. C. Jacobson, Engr., Metropolitan Bldg., Minneapolis, Minn., will soon award the contract for the construction of a power house, diversion dam, headrace and equipment on Red Cedar River, for the Colfax Electric Co. Total estimated cost, $100,000.

Ia., Maquoketa—The city will soon award the contract for the construction of a complete electric plant, to include a 250 h.p. oil engine, generator, exciter, switchboard, 12,000 gallon oil tank, distribution line, transformers and meters. G. O. Morse, Supt.

Minn., Duluth—M. S. Cook, 317 East 3rd St., will receive bids until January 1 for the construction of a 2 story, 118 x 140 ft. theatre on West Superior St., for the Cook Enterprise Co., 313 West Superior St. Steam heating and mechanical ventilating systems will be installed in same. Total estimated cost, $500,000. Rupp & Rupp, Chicago, Ill., Arch. and Engr.

Minn., Duluth—The McDougall Duluth Co., 85th Ave., W., is in the market for high pressure pump, 1 vertical complex pump, 1 general service pump, 1 low pressure pump, 1 main circulating pump and 1 centrifugal pump.

Kan., Valley Center—The city will soon award the contract for furnishing two 60 gallon plunger pumps with motors and constructing two 12 in. wells with derricks and pump houses, etc. Ruckel Engineering Co., Hutchinson, Engr.

Neb., Omaha—The Omaha Cold Storage Co., 8th and Farnam St., will soon award the contract for the construction of a 5 story 132 x 154 ft. addition to its plant. Total estimated cost, $250,000. B. H. Gibson & Co., 608 South Dearborn St., Chicago, Arch.

Mo., Kirksville—The city is having plans prepared for improvements to the water works system, including one 100 h.p. water tube boiler, two 100 h.p. oil engines, two 600 G. P. M. centrifugal pumps, etc. Total estimated cost, $30,000. W. B. Rollins & Co., 209 Railway Exchange Bldg., Kansas City, Mo., Engr.

Colo., Lamar—The Town Council will soon award the contract for the construction of a water works system, also an electric light plant, consisting of general power plant supplies, engines, generators, boilers, pumps, etc. Total estimated cost, $200,000. Royal D. Salisbury, 1415 Colfax Ave., Denver, Engr.

Colo., Peetz—The Town Council will soon award the contract for furnishing material and labor for additions and extensions to the pumping plant, consisting of two 35 h.p. internal combustion oil engines, two 2300 volt generators for direct connection to the above, one switchboard, one deep well pump for 500 ft. head, pumping station accessories, etc. Total estimated cost, $25,000. Royal D. Salisbury, 1415 East Colfax Ave., Denver, Consult. Engr.

Ore., Eugene—The Eugene Fruit Growers' Association plans to build a 2 story, 50 x 50 ft. artificial ice plant addition. Estimated cost, $8000. J. O. Holt, Mgr.

Ore., Vale—The Shattuck-Edinger Co. is having inspections made, preliminary to extending Nevada Irrigation Ditch, installing pumping plant, enlarging the mill ditch to capacity sufficient to carry the Gellerman-Froman Ditch water from Willow Creek pumping to Nevada Ditch diversion. Total estimated cost. $75,000. J. Lewis, Mgr.

Cal., Richgrove—The Southern California Edison Co., Edison Bldg., Los Angeles, plans to construct a 43,000 h.p. hydro electric system, dam, tunnels and fumes to divert 600 cu. ft. water per second from North Fork of Kern River, Tulare County, to company's sub-station here. Total estimated cost, $9,231,358.

Cal., Santa Barbara—The Southern Counties Gas Co., 724 Spring St., Los Angeles, plans to extend its compressor and boiler house here. Estimated cost, $4000. J. D. Thompson, Chief Engr.

Cal., San Diego—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids until November 19 for the construction of a central building, consisting of a power house, etc., at the Marine Corps Base here. Estimated cost, $200,000.

Alaska, Petersbury—The City Council adopted a resolution to purchase a site adjoining the city, near the lake, and build a 5000 h.p. hydro-electric power plant. Estimated cost, $75,000.

Hawaii, Pearl Harbor—The Bureau of Yards & Docks, Navy Department, Washington, D. C., received bids for the construction of a power plant at the naval station here, from Adams Bretz & Co., 1959 Park Ave., New York City, $84,321; John W. Danforth, 72 Ellicott St., Buffalo, N. Y., $105,216; Stewart Engineering Corporation, 61 Broadway, New York City, $117,471. Noted September 30.

Ont., Toronto—The Hydro-Electric Power Commission of Ontario, University Ave., plans election in January to vote on by-law for $8,360,000, to build 48 miles railway from here to Bowmanville (80 lb. track), to include transmission line 48 miles long. Scarboro Township will appropriate $900,000 and Pickering Township $300,000 toward cost. F. C. Gaby, University Ave., Engr.

Ont., Wingham—The town voted $40,000 bonds, thereby authorizing the Hydro-Electric Power Commission of Ontario to build a power plant and distribution system. Plans include 30 miles of power line from here to Eugenia Falls. F. A. Gaby, Hydro Bldg., Toronto, Engr. Noted July 8.

CONTRACTS AWARDED

Conn., New Haven—The Edward Malley Estate, 902 Chapel St., has awarded the contract for the construction of a 2 story boiler and engine room on Temple St., to the Larkin Carey Co., 166 Brewery St. Estimated cost, $30,000.

N. Y., New York—The Uneeda Ice Co., Inc., 666 East 187th St., has awarded the contract for the construction of a 3 story, 74 x 90 ft. ice plant on Jumel Pl. and 167th St., to the Lustbader Construction Co., 103 Park Ave.

Pa., Philadelphia—The Breyer Ice Cream Co., 8th and Cumberland St., has awarded the contract for the construction of a 1 story, 50 x 78 ft. boiler house, on 8th and Cadwallader St., to W. F. Koelle & Co., 26 Oxford St. Total estimated cost, $10,000.

Md., Annapolis—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of a power house addition, an ash bunker, to Levering & Garrigues, 552 West 23rd St., New York City, $81,877. Noted September 30.

Md., Baltimore—The Consolidated Gas, Electric Light & Power Co., Lexington Bldg,. has awarded the contract for the construction of a 2 story, 53 x 58 ft. electric power service building, at Westport, to Arthur Tufts, 1401 Lexington Bldg. Total estimated cost, $50,000.

Md., Silver Run—A. W. Feezer has awarded the contract for the construction of a power house, canning factory and corn storage building to the Roystone-Craig Engineering Co., Westminster. Total estimated cost, $50,000.

Ky., Ashland—The Board of Water Commissioners has awarded the contract for the construction of a centrifugal pumping plant, to consist of 7 units, to J. E. Nelson & Sons, 117 North La Salle St., Chicago, Ill.

Ohio, Cleveland—The Board of Education, 1663 Lee Rd., has awarded the contract for the installation of feed water pumps and 2 Hart boilers, in the proposed 2 story, 110 x 176 ft. school addition on Roxboro Rd., to Chappell-Warren Co., 1830 St. Clair Ave. Total estimated cost, $400,000. Noted January 7.

Ohio, Cleveland—The Board of Education, 6th St. and Rockwell Ave., has awarded the contract for the installation of a boiler, radiators, piping, valves and ventilating system, in the proposed 3 story, 83 x 139 ft. public school addition on Miles Ave., to the Miles Heating & Ventilating Co., Park Bldg. Total estimated cost, $250,000.

Ohio, Cleveland—Friedman Blau Farber Co., East 37th St. and Perkins Ave., has awarded the contract for the construction of a 1 story 45 x 60 ft. boiler house to C. N. Griffen, 5509 Euclid Ave. Estimated cost, $50,000.

Ohio, Cleveland—The Prame Realty Co., 214 Williamson Bldg., has awarded the contract for the construction of a 4 story, 107 x 140 ft. commercial building on 27th St. and Payne Ave., to Craig Curtiss Co., 1030 Guardian Bldg. A steam heating system, including two 150 h.p. boilers, stokers, generator, etc., will be installed in same. Total estimated cost, $250,000.

POWER

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HE SHOULD WORRY

Lap Seam Boiler Explodes

Another explosion of a boiler as the result of a lap seam crack occurred at the power plant of the Sisters of St. Francis of Assisi, St. Francis, Wis., a suburb of Milwaukee, at about 10 o'clock Sunday evening, Nov. 2, 1919. The boiler was 60 in. diameter, 14 ft. long, and constructed of 3/8-in. plate of flange steel having a tensile strength of 60,000 lb. per square inch, as shown by the steelmaker's brand. There were two sheets of the shell plates, each sheet forming a complete ring with the longitudinal seam at the usual place, above the watre line. The boiler was built in 1904.

The longitudinal seams were of the double-riveted lap-joint type, there being two rows of 7/8-in. rivets driven in 15/16-in. holes. The rivet spacing being 3¼ in. gave a joint efficiency of approximately 71 per cent, the net section between rivet holes being the weaker. The spring loaded safety valve of this boiler was set to blow at 95 lb. pressure, giving the boiler at the maximum allowable pressure a factor of safety of 5.6.

The boiler that exploded as well as the other two boilers in the plant were examined on Sept. 22 by an insurance company inspector, and on the morning of Oct. 25 the engineer who has had charge of the plant for over eight years cleaned and examined the boiler and prepared it for service. The cleanliness of the boiler and its freedom from other defects indicated it had received good attention in every way.

From the information obtainable, it appears that boilers Nos. 1 and 3 were temporarily out of service, with the manhole plates removed, and boiler No. 2 was being used for supplying the lighting load and for heating the premises. On Nov. 2 the boiler was being operated as usual. At about 5 o'clock p. m. the pressure reached 95 lb., and the safety valve operated freely as it had done daily for a week or more previously. After the accident, the safety valve was found to be perfectly free and unobstructed.

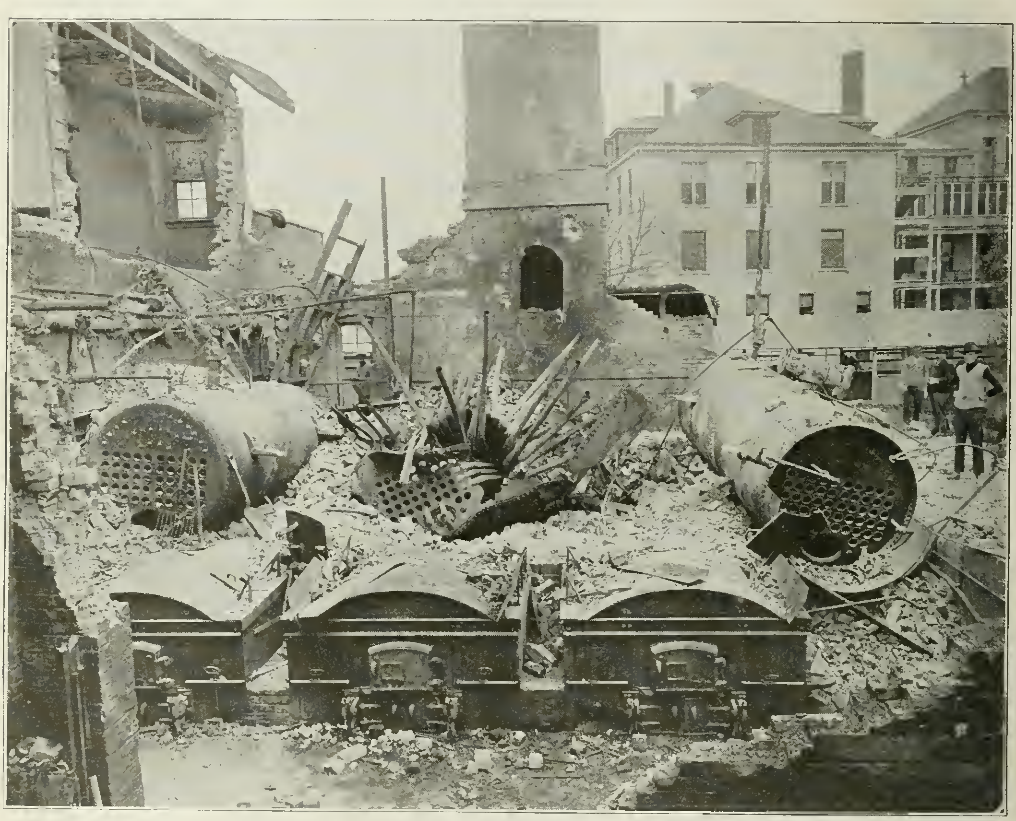


FIG. 1. LAP SEAM BOILER EXPLOSION AT ST. FRANCIS, WIS.

At 8 p. m. of that day the fire was banked for the night, the steam having been shut off from the buildings and the electric lights switched to the storage battery. The pressure gage indicated 40 lb. pressure and the water stood at three gages. After locking up the plant the engineer left the premises. Two hours later the boiler exploded quite violently, demolishing the greater part of the boiler room building and damaging the laundry building wall adjacent to the boiler room. Boilers Nos. 1 and 3 were forced from their settings and parts of the boiler room equipment were projected to a distance of 400 or 500 feet. No one was injured by the accident. The property damage approximated $10,000.

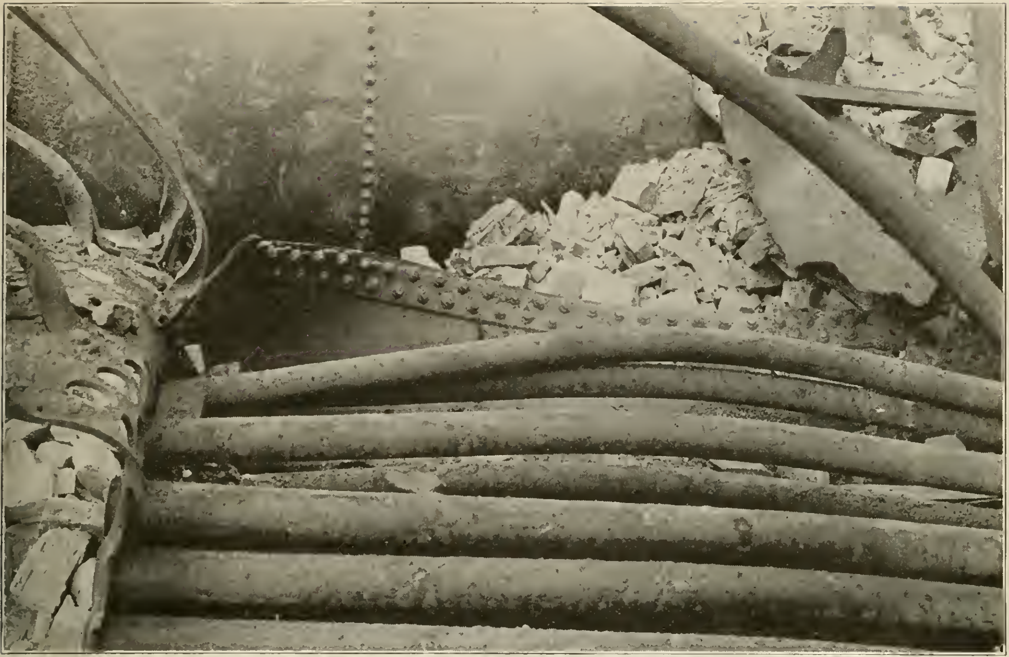


FIG. 2. CLOSE-UP VIEW OF RUPTURED SEAM

Examination of the exploded boiler developed the fact that the front course of the shell plate had failed from the head seam to the girth seam, a distance of 6 ft. 9 in., along the rivet holes of the double-riveted lap seam, as plainly seen on the "close-up" view of the sheet, Fig. 2. The crack probably started at a point about 5 ft. from the front head, where the plate was not homogenous, and gradually extended to the front head seam, working deeper into the sheet until separation occurred.

That part of the seam between the laminated spot which did not appear on the surface, and the first girth seam, contained no indications of an old crack, and by the reduction in thickness and elongation, the material would be judged to be of good quality. The seam had given no warning of its condition, as there had been no leakage, and in fact the boiler since its installation had never been repaired in any way.

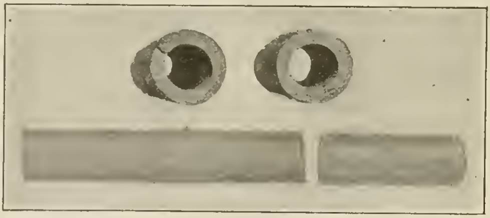
It will be seen from the photograph of the ruins, Fig. 1, that the force of the explosion was a clear indication of the amount of water contained, so that the low-water theory may be discarded. As is usually the case where the failure occurs above the horizontal diameter, the force was expended principally upward, and the boiler was moved but a short distance from its proper position. The banked fire remained on the grate of the dutch-oven furnace, the latter being practically intact.

Of course no one can state positively what took place after the fire was banked and the flow of steam from the boiler ceased, but those who have had to do with boiler operation will easily conclude that with hot furnace walls, a freshly banked fire, a boiler filled with water, and steam at 40-lb. pressure, and the steam produced no longer being used, there would be an increase in pressure which under certain conditions might reach the amount to which the safety valve is set, in this case, 95 pounds.

The boiler had safely withstood 95 lb. pressure at 5 o'clock, but had probably been on the verge of failure for several days.

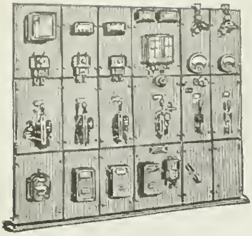
Tensile Tests of Thermit Pipe Welds

Two tensile tests of Thermit pipe welds were recently carried out for the Carnegie Steel Company, Clairton, Pa. The welds were made on two sections of 2 in. extra heavy steel pipe and the specimens were then pulled on a tensile testing machine. The first pipe broke under a total load of 113,800 lbs. and the fracture was 4 in. from the weld. The second pipe broke 4⅝ in. from the weld under a load of 124,000 lbs.



SECTIONAL VIEW OF FRACTURE

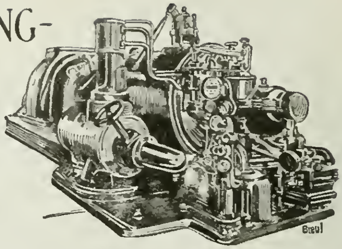
The illustrations show a cross section of the fracture and a side view of the specimen giving the location of the fracture and of the weld on one of the pieces tested. Since the pipe did not break at the weld in either case the welds were evidently stronger than the pipe and the figures given are less than the breaking strength.



PUTTING AN ALTERNATING-CURRENT GENERATOR IN SERVICE

By

Frank Gillooly



The process of putting an alternating-current generator of medium size on the bus for the first time is discussed, and such features as drying out the windings, making insulation tests, phasing out the machine, division of load, etc., are considered.

PLACING a new unit in service is not a difficult job when the various operations are understood and the whole process is viewed from an operating standpoint. This article will consider the initial loading of a three-phase 60-cycle 2300-volt turbo-alternator of medium size, which is a representative unit. Three-phase distribution is the most economical system for power, which forms the bulk of the load on most plants; and 2300 volts is the bus potential of many private plants and small generating systems. The unit would probably run 1800 r.p.m., although 3600 r.p.m. is not an uncommon speed for turbines up to 2500-kv.-a capacity. The alternator in the former case would have four poles; in the latter case, two poles.

Alternators are now rated either in kilovolt-amperes (kv.-a.) or in kilowatts (kw.) at a specified power factor. An alternator rated 1000 kw. at 80 per cent. power factor, is equivalent to 1000 ÷ 0.80 = 1250-kv.-a. machine. This rating is important, since it determines the full-load current of the generator and affects the voltage regulation.

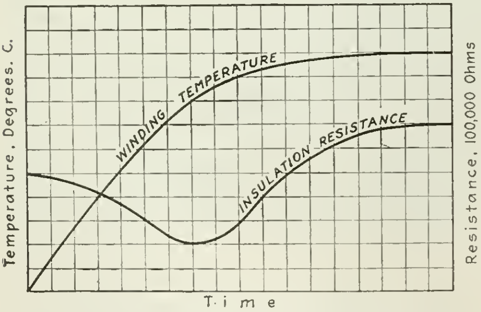


FIG. 1. TEMPERATURE AND INSULATION RESISTANCE CURVES

Temperature indicators are usually connected into different parts of the armature winding or at some part of the machine where a reading may be obtained which, when increased by the factor representing the difference in heating between that point and the hot-test spot, usually 15 deg. C., if thermometers are used, gives the temperature indication. The maximum allowable temperature rise in insulation of the kind now used in alternators is 85 deg. C. and the maximum safe operating temperature 125 deg. C.

It may be desired to test the insulation, which has been guaranteed for certain standardized pressures by the manufacturer, before the machine is placed in regular operation. Such tests are customary on all armatures, but are made only on the fields of large units or when necessary on small fields.

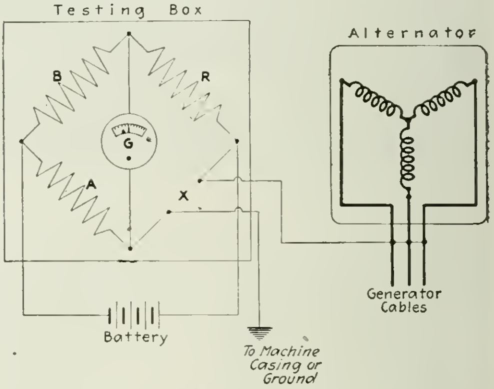


FIG. 2. TESTING INSULATION RESISTANCE WITH WHEATSTONE BRIDGE

The field winding may be dried out by passing current through it. For this, leads must be run from a separate exciter or other direct-current source, through an ammeter and rheostat, to the terminals of the winding. Current not greatly exceeding full-load will be circulated through the winding until the heat of the conductors has dried their insulation. From time to time the resistance of the insulation and the temperature rise of the winding should be measured; and the drying-out will be continued until the resistance reaches its maximum value. A breakdown test may be made after the heat-run. It should be for approximately ten times the operating voltage of the winding, but never for less than 1500 volts or more than 3500 volts. After any heat-run a machine must not be allowed to cool too quickly, or its windings will "sweat" and become moist again.

On large machines assembled on the customer's premises, each armature coil is given an initial breakdown test when it is fitted into its slot. In the machine under consideration the armature would come completely assembled, and the breakdown test would be made on the whole winding after the armature heat-run had been made to dry it out and test its temperature rise.

When the unit has been assembled a mechanical inspection will be made to see that all bolts, nuts and joints are tight, that no tools are lying around or in the machine, that all scaffolding and forms have been removed, and that all ducts are clear. An electrical inspection is also made. The phase rotation of the alternator has been determined at the factory and all armature connections marked. All cables should be traced back to the bus and their connections checked. Connections are gone over with wrenches to insure good contact. Slip rings and brushes are cleaned and inspected and brush tension adjusted on the alternator, as well as on the separate exciter if the unit has one. The rheostats and their contacts and control should be inspected as should all control circuits, the field-break switch, and the governor motor. On the last the direction of rotation and the limit-switch cutouts should be tested. The instruments should be calibrated, the synchronizing circuits checked, the oil switch tried and its operating characteristics noted by the men who must use it in synchronizing. Meanwhile, steam will have been turned on and the unit rotated slowly to test the steam joints and seals for leaks. The machine is then ready for its heat-run.

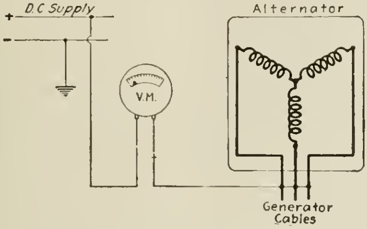


FIG. 3. TESTING INSULATION RESISTANCE WITH VOLTMETER

Making the Heat-Run Test

The heat-run is made by running the machine on dead short-circuit. Each phase of the armature is short-circuited through heavy cables capable of carrying the full-load current of the machine. These cables are connected on the machine side of the oil switch, or at the machine disconnecting switches if there are such. The short-circuit connection must always be made beyond the generator current transformers, so that the ammeters of the machine will be in circuit. The generator field-break switch is then closed, with all rheostat resistance in, preferably on a separate exciter at low voltage, and the speed and field excitation gradually increased until the armature is carrying full-load current. During the test the ammeters must be carefully watched to apprehend any further current increase due to increases in speed or exciter-voltage. Whenever it is desired to interrupt the test, the short-circuit must not be removed from the armature until after the field switch is opened, or there will be a dangerous voltage rise in the former if the machine is running.

The short-circuit, or heat-run, test is continued for twenty-four hours or more. From time to time the test is stopped to measure the insulation resistance and the temperature of the winding. Insulation resistance is always lower when hot than when cold. At first it will drop, then continue to rise until the point is reached at which it becomes constant. The value for the resistance of the insulation at operating temperaure given by the A. I. E. E. Standardization Rules, is

$$\textit{Resistance in megohms} = \frac{\textit{terminal voltage}}{\textit{kv.-a. rated capacity} + 1000}$$

and it should never be less than one megohm.

During the heat-run all apparatus should be inspected for loose connections and heating. The temperature rise of the armature must be studied, for it will govern the output of the machine when in regular operation. A curve may be drawn, as in Fig. 1, showing the temperature at intervals during the test. The insulation resistance at various temperatures may also be plotted on the curve. Care should be exercised in locating the thermometers. When placed against a part of the machine, the bulb must be covered with felt or putty to prevent cold air affecting the readings; and the bulb must never be lower than the tip or the mercury column may separate.

Measuring Resistance of Insulation

The resistance of the insulation may be measured with a megger, a Wheatstone bridge, or a voltmeter. The megger generates its own testing potential and reads directly in ohms, so that it need only be connected to the winding and to ground. The megger leads must be well insulated and the connections clean and solid, in order to secure accurate readings.

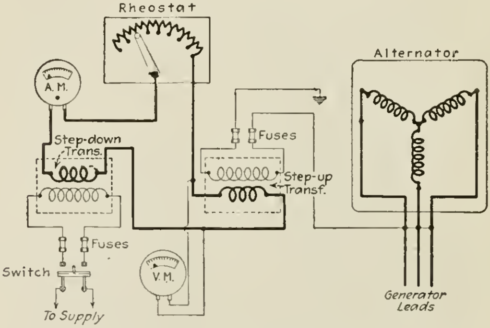


FIG. 4. CONNECTIONS FOR MAKING POTENTIAL TEST ON WINDING INSULATION

The Wheatstone-bridge set employs a battery potential to obtain a galvanometer deflection in a series-parallel circuit containing a number of known resistances and the resistance to be measured. The value of this unknown resistance, X, Fig. 2, is derived from the formula,

$$X = \frac{AB}{R}$$

where A, B and R are the known resistances. Leads from the terminals for X on the testing box are connected to the winding and to ground, as shown.

In the voltmeter method, Fig. 3, a direct-current supply is used. A reading V is taken on the voltmeter across this supply. Then the voltmeter is connected in series with the machine winding, the supply, and ground, as shown, and a second reading v taken. The resistance of the voltmeter, as marked on its case, is r. The winding resistance R in ohms is then

$$R = \frac{r(V - v)}{v}$$

and in megohms,

$$R = \frac{r(V - v)}{v \times 1,000,000}$$

After the armature has been dried out, the insulation test will be made on it by applying a high voltage between the winding and ground. A. I. E. E. Standardization Rules call for a testing potential of twice operating voltage plus 1000 volts, for machines operating at less than 2500 volts, to be applied for one minute. This test must neither be prolonged nor made too frequently, nor at a time when the insulation resistance is low, lest the winding be damaged.

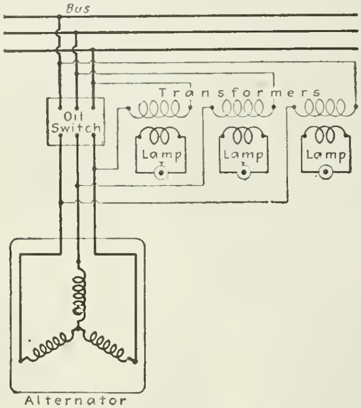


FIG. 5. CONNECTIONS FOR PHASING OUT AN ALTERNATING-CURRENT GENERATOR

The testing potential is obtained through a set of transformers, Fig. 4. One transformer steps down the voltage, which is then fed through a resistance into a second transformer and stepped up to the testing pressure. The voltage is varied as desired through the resistance in the low-tension circuit. Its value at any instant is obtained by multiplying the reading of the voltmeter connected across the low-tension circuit by the ratio of the step-up transformer. An ammeter in series with the resistance shows the current taken by the transformers, and a breakdown of the insulation would be apparent from a sudden increase in the current. Where sufficient potential cannot be obtained from one transformer, two or more units may be used connected in parallel on the low-voltage side with the high-voltage windings connected in series.

The high potential must be applied gradually. The testing transformers must be of sufficient size so that the static capacity of the winding may not overload them and distort their wave form. A distorted alternating-current voltage wave form may have an abnormal peak value. The dielectric stress on the insulation is equal to the maximum value of the testing voltage and should not exceed that of a sinusoidal voltage having an effective value equal to that of the prescribed testing pressure. In general, a testing transformer of 1-kw. capacity will be sufficient for testing voltages up to 2000 volts, and one of 3-kw. for voltages up to 6000 volts. The high voltage should always be reduced before breaking the circuit, to prevent any disturbance that might follow the sudden changing or interrupting of the strong magnetic field. For the same reason the resistance used in the low-tension circuit should be cut in or out without opening the circuit; in this connection an induction regulator is much better than an ordinary current-limiting resistance.

How the Speed Test Is Made

When the breakdown test has been made, the machine is ready for a speed test. After an inspection has insured that its switches are all open, the unit is turned over; when at one-half or three-quarters speed, the field-break switch is closed, with all resistance in on the rheostat. The unit is then brought to speed. Balance adjustments are made if necessary due to vibration. A governor speed-range test is made by operating the governor-motor over its full travel and noting the total change in speed or frequency. Should this range be too high or too low, changes are made in the governor-spring tension to bring it within the desired limits. The speed-range determines the maximum and minimum speeds of the machine under governor control. The emergency trip should be tested by speeding the machine until the trip operates, and adjustments made to cause it to operate at the desired figure, somewhere from 7 to 15 per cent. over speed.

The generator is then brought up to full voltage gradually, and all ammeters watched for abnormal current. Should trouble develop, the field-break switch should be at once opened. Apparent failure of the generator to build up its voltage, or evidence of unsteady voltage, may be caused by a blown potential transformer fuse, poor commutation or loose connection on the exciter or alternator slip rings, poor or open connection in a rheostat or in the instrument wiring.

Phasing Out the Machine

Before the machine may be paralleled with the other units, it must be phased out to insure that its phase rotation is the same as theirs—this apart from merely synchronizing the machine, which is done on only one phase. The simplest of the several methods of phasing out a machine consists in connecting a transformer across the open-circuit of each phase at the oil switch, Fig. 5, and noting whether the lamps connected in the secondaries of these transformers grow bright and dark in unison or in succession. If the phase relations are correct, there will always be the same difference of potential across all the jaws of the switch—whether this potential is zero when the machine and bus are exactly in step, or the sum of the voltages of the machine and bus when they are 180 deg. out of synchronism—therefore, all lamps will grow bright or dark together.

Should there be any difference in the brilliance of the lamps when they are all of the same type and size, one of the phases is crossed and two of the machine leads will have to be interchanged and the test repeated. In this test it must be remembered that, periodically, when the machine and bus are opposite in phase, the voltage across the jaws of the open switch is the sum of their respective voltages and that this is the voltage on the primary of each transformer. The voltage of the phasing lamps, then, must equal the quotient of twice the bus voltage divided by the ratio of the transformers.

Unless each generator panel has its own phasing lamps and the station has duplicate buses and the new machine may be placed on the bus not in use and phased against the running machines, it is unsafe to phase out between the instrument transformer secondaries of the new machine and the bus, or a running machine's transformer secondaries, because any error in the circuits of the new apparatus would give an incorrect test. When phasing out, and even when synchronizing, the synchronoscope should be checked against the phase lamps to determine that it is at the synchronizing point when the lamps are dark. The phasing-out process is a most important operation. Were the generator to be closed on the running bus while out of phase with it, a short-circuit would be produced.

When the machine has been phased and found correctly connected, it may be parallel with the running machines after the synchronoscope has also been checked against the phasing lamps. If a separate bus is available or if the station can be shut down during the test, it is better to parallel the new machine against one that is carrying no load; as there is less likelihood of damage to the machine in service due to any failure of the new machine. The oil switch should have previously been tried and its action noted in comparison with those of the other machines. After closing the machine on the bus, its field excitation must be adjusted to obviate cross-currents with the other generators. This is accomplished by raising or lowering on the generator rheostat until the armature current is at its minimum.

The new unit should be loaded gradually over a period of a day or two, in order to give all parts a chance to wear in and heat up. During the initial runs frequent adjustments will be necessary on the governor to make it act uniformly with the governors of the units with which it must operate in parallel.

THE NEW UNIT SHOULD BE INSPECTED FREQUENTLY

The unit should be shut down frequently during the first few weeks and a complete inspection made to forestall the failure of any part. Bearing temperatures must be closely watched during the first runs. Vibration and rubbing should be looked for, as both cause heating, either from friction or from an unequal magnetic field. The end bells should be removed and the armature inspected to see that no dirt or oil is collecting. Dirt on the windings increases their heating, and oil softens and rots insulation. The screens over the air intake should be frequently cleaned; when they become dirt-clogged, the amount of cooling air is reduced. Dampers should be closed whenever the unit is shut down and opened gradually when it is started, to prevent condensation or the windings from the cold air. The air entering the machine when it is standing should never be of lower temperature than the air of the room.

After the unit has carried full load, its most efficient loading points should be determined, if possible, by plotting a curve of its steam consumption at various loads up to and above full load. Plant efficiency will depend on the efficiency of the individual units, so that the economical loading of each machine is a factor worthy of study.

Correcting Power Factor With Idle Transmission Lines

By L. W. Wyss

The scheme described in this article is not new to operators of most power-transmission systems employing long, high-tension lines; namely, to use idle transmission lines as condensers to raise the power factor of the system, even though they are not used for transmitting power. In a generating system consisting of a 1200-kv.-a. hydro-electric station which delivered power over a 90-mile 66,000-volt duplicate transmission line to a combined substation and steam plant, four towers were blown down during a severe windstorm. It would require from 24 to 48 hours to erect some kind of a temporary line to bridge the gap, because of the rough country and bad weather conditions.

The steam plant was now required to handle the full load, which averaged about 8500 kw. except during the light-load periods. The average power factor of the system was about 0.75 lagging, making the kilovolt-ampere load equal to $8500 \div 0.75 = 11,330$, but in the steam station the total capacity of the plant was only 9250; therefore the generators would be seriously overloaded. There were two ways of reducing the load on the station—to cut off some of the power users' circuits, or to improve the power factor, the latter being given preference. A lineman was ordered to cut the 66,000-volt line at the most convenient place on the steam-plant side of the break, after which the line was energized. When the line was used as a condenser, it furnished 2830 reactive kilovolt-amperes at a leading power factor. This reduced the load on the station to 9650 kv.-a. and raised the power factor to 0.88—a load that the generators could handle without being overloaded.

In another case on a small transmission system where the original installation consisted of a steam plant with two engine-driven units of 80- and 210-kw. capacity respectively and a 500-kw. steam-turbine unit connected over a 12-mile 11,000-volt line, with a 640-kw. hydro-electric plant, the load had increased to a point where it was decided to build another hydro-electric station and tie it on the system through a 38-mile single-circuit 40,000-volt line. However, before the new plant was finished, the other stations, became very heavily overloaded, mainly because they delivered load at about 0.72 power factor. The average load during the heavy-load period was 1275 kw. at 0.72 power factor, or 1770 kv.-a. The 40,000-volt line was completed and the transformers, switches and lightning arresters were installed at the steam plant. It would be a number of weeks before the new plant would be ready to run, therefore it was decided to use the line for power-factor correction. The 480 reactive leading kilovolt-amperes obtained from the line raised the power factor of the system from 0.72 to 0.86 and consequently cut down the kilovolt-ampere load of the generators from 1770, before the line was used as a condenser, to 1480 kv.-a. after the scheme was put in effect. In addition to this the 40,000-volt line and equipment received a good tryout before being put into regular service.

Hagan Combustion-Control Regulator

The amount of steam generated by a boiler determines the quantity of fuel and air that must be supplied. It is therefore apparent that the fireman is feeding fuel and air to the boiler furnace in accordance with the flow of steam from the boiler. Working on this basis, the Hagan Corporation, Pittsburgh, Penn., has developed a system of combustion control that regulates the fuel and air supply in accordance with the flow of steam.

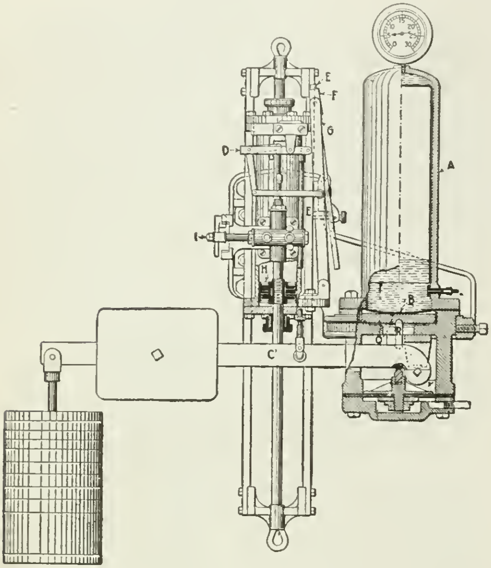


FIG. 1. SHOWING DETAILS OF THE REGULATOR

The apparatus is sensitive to small variations in pressure, and it is therefore possible to operate the regulating mechanism on the small differential pressure due to flow, which may be secured by inserting a standard plate orifice in the steam line.

In regulating the damper and stoker two distinct devices are used, the damper being controlled by the regulator, Fig. 1, which is fitted with an adjustable compensator, and a roto reciprocating valve, Fig. 2, for controlling the stoker speed. Fig. 3 shows how these two appliances are arranged for use with a natural-draft boiler and how the movement of the regulator is communicated to the roto valve.

By means of an auxiliary air cushion and a secondary diaphragm *B*, Fig. 1, the regulating mechanism is made to take an incremental movement for variations in rate of flow or steam pressure between the two extremes for which the apparatus is adjusted, and there is no tendency to regulate from one extreme to the other except in case of a sudden change in demand from one extreme to the other.

A plant having a steady load can obviously have closer regulation than one where there are great fluctuations in steam demand, and the sensitiveness of the regulating apparatus must therefore be capable of adjustment. This is secured in two ways: First, by varying the pressure in the air chamber *A*, and, second, by changing the angularity of the adjustable compensator. By means of these adjustments it is possible to secure a full stroke of the regulator with a differential pressure as small as 1 oz. or as great as 15 lb.

As the movement of the weight arm is transmitted to the rocking frame which carries the pilot valve there will be a definite movement of the pilot valve for each increase or decrease in pressure, and this movement, combined with the action of the compensating device, makes it possible to adjust the regulator so that the piston will move incrementally with variations in applied pressure under the diaphragm, and these increments can be varied in extent to suit local conditions.

With a movement of the diaphragm sufficient to open the pilot valve the movement of the plunger will continue until the pilot is closed by the compensating mechanism. The compensating bar can be set parallel with the direction of movement of the plunger, and there will be no compensating action, a minute opening of the pilot valve producing a full stroke of the regulator. By increasing the angularity of the compensator the length of stroke secured for each movement of the pilot valve will be reduced.

The operation of the adjustable compensator is as follows: The weighted lever *C* of the regulator moves up with a decrease in flow or an increase in pressure. The movement of this lever is transmitted through an adjustable rod to the rocking frame *D*. A bell crank is connected to the pilot valve stem by means of a link and to the compensator lever *E* by means of a second link.

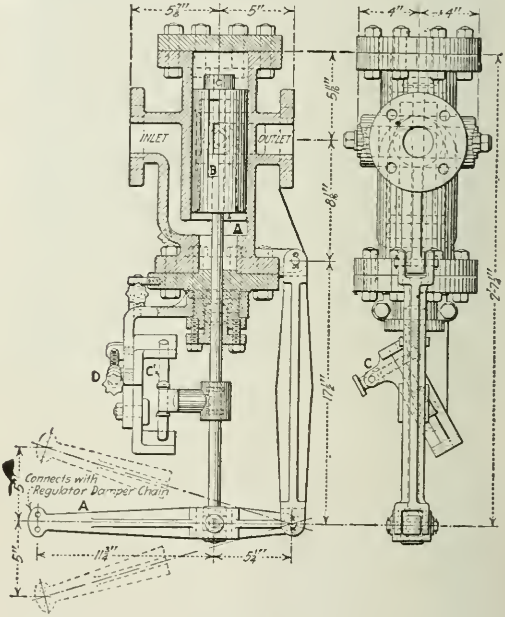


FIG. 2. DETAILS OF THE ROTO RECIPROCATING VALVE

The guide bar carries a bracket on which is pivotally mounted the adjustable compensating bar *E*. By means of the adjusting screw the angularity of the adjusting bar *E* is changed. At the top of the compensating lever *G* is a guide shoe *F*, in which the bar *E* slides. When the regulator is in operation a downward movement of the crosshead *R* and compensating bar *E*, sliding through the shoe *F*, will move the compensating lever *G* to the left, causing the pilot-valve stem to move down until the valve is closed, stopping the movement of the piston. The distance the piston *H* will travel to shut the pilot valve after it has opened, or vice versa, depends upon the angle given to the compensating bar *E*.

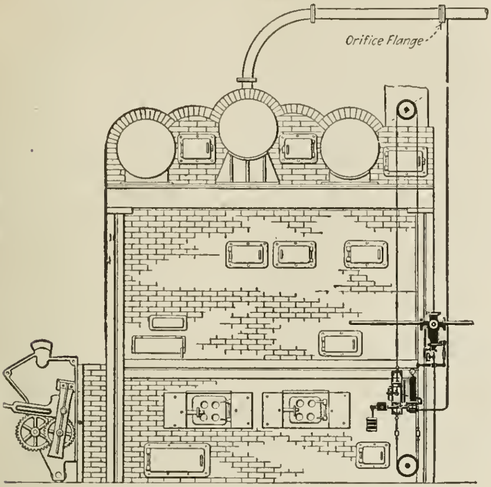


FIG. 3. CONTROL APPARATUS AS IT IS CONNECTED TO A BOILER

When blowing tubes the boiler dampers should be kept wide open, irrespective of the steam demand on the boiler or the steam pressure. A bypass valve *I* is therefore provided as a part of the mechanism, by which the regulator may be thrown in its wide-open position and kept there independently of any variations of flow or pressure. This bypass valve can be thrown in a reverse position and the regulator moved to a closed position and held there. In the mid-position of this valve the regulator is operative from variations in flow and pressure. In order that the full advantages of such a regulator may be realized, it is necessary to incorporate into the system of regulation a regulating valve, by means of which the speed of stokers and draft fans can be controlled with a degree of accuracy equal to that which the the regulator itself responds to variations of flow and pressure. To accomplish this, a roto-reciprocating valve is used (see Fig. 2). This valve is of the piston type, the piston having a combined reciprocating and rotating motion. The reciprocating motion is imparted to the valve by the regulator, and the rotating motion is adjustable from the outside of the valve to suit the existing conditions.

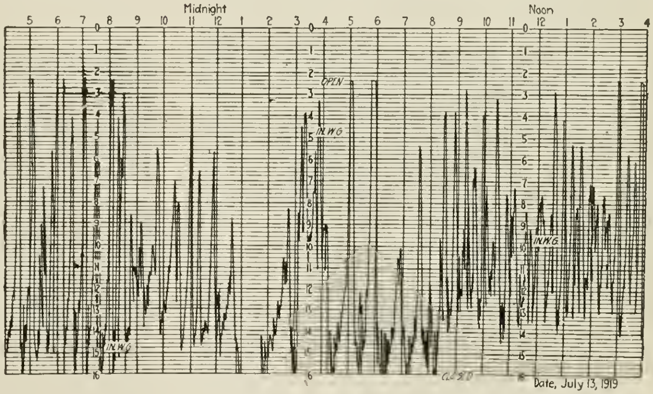


FIG. 4. CHART SHOWING MOVEMENT OF THE ROTO VALVE

The minimum opening of the valve that will be required to meet any given condition is determined, and the valve is set to give this desired minimum. It is then possible to start from this minimum, and by using the full stroke of the valve at all times, adjusted for any desired rate of increase and any desired maximum. These adjustments are made from outside.

The movement of the valve is controlled by the travel of the regulator piston in moving the damper chain. The roto-valve cylinder is cast with a port that extends from the inlet to a chamber below the hollow piston *A*, Fig. 2. This piston is made with slots *B* which are open to the exhaust ports cast in the cylinder and communicate with the outlet opening.

The regulation of the volume of steam is brought about by the reciprocating movement of the valve, which also has a rotating movement. This is accomplished by means of an angular adjusting head. The valve piston is first set so that the least desired amount of steam is passed through the valve slots to the outlet, say, sufficient to operate one stoker engine or turbine at minimum speed. With the head set parallel with the valve piston the valve opening remains the same, regardless of the position taken in a reciprocating movement. If a second unit is put on the line it is only necessary to adjust the angle of the adjusting-head rod *C* to a degree that will supply the steam. This is done by the screw *D*. If more engines are put on the line, the angle of the head is increased

When the piston is down to the zero point, any adjustment of the adjusting head does not change the port opening of the valve, but as soon as the piston begins to move, the crosshead sliding on the angular adjusting head rod *C* produces a rotating movement to the valve and gradually opens the port, owing to its rotating motion as the piston moves upward. If sufficient angularity is given to the adjusting head, the valve will move in a rotating direction from just a crack to wide open while it is making its stroke. As the piston *B* is moved up or down by opening or closing of the damper, the roto valve acts in unison with the regulator and closes off the steam to the stoker and fan engine with the closing of the damper, and admits steam with the opening of the damper.

As a matter of fact, the damper or roto valve seldom closes during ordinary running conditions, but is operating in some mid-position between open and closed, the position depending on the load. This is shown by the chart, Fig. 4, taken with a Hagan regulator control. From 8:15 p.m. until 5 a.m. the regulator did not reach the wide-open position, and from 8:15 a.m. to 3 p.m. the regulator never reached either extreme position.

Refrigerating-Plant Economy Simplified

By VICTOR J. AZBE

EFFICIENT operation of a refrigerating power plant depends on a number of factors, each of which exerts an influence on general economy. For example, there is excess air, CO_2 in the flue gases, the flue-gas temperature, the carbon in the ash, the feed-water temperature, the steam pressure, the back pressure or vacuum at the engines or steam pumps, the ammonia condenser pressure, the ammonia suction pressure, the temperature of the water to be frozen, the temperature of the liquid ammonia, the heat lost through uncovered steam and ammonia pipes, the auxiliary power required per ton of ice, the cost of ammonia per ton of ice, etc.

It is impossible for an engineer to state with a great degree of accuracy what influence a certain change in operating conditions will have except by consulting textbooks or referring to tabular data. Great accuracy under practical conditions is seldom required, and to be able to tell offhand from memory with an approximate degree of exactness what, for example, the increase of ammonia suction pressure by one pound means from the economy standpoint is of the greatest value and is what makes good engineers, since it teaches them to appreciate small items.

Approximate Data Close Enough for Practical Purposes

In the following paragraphs approximate data in simple form are given. Since these factors vary, they are accurate at a certain point and off at others, but generally speaking, the figures given are close enough for all practical purposes.

In the boiler room the percentage of CO_2 in the flue gases is used to judge the loss due to excess air. This factor is modified by the temperature of the flue gases. With a flue-gas temperature of 550 deg. F., each one per cent. increase in CO_2 between 7 and 9 per cent. represents a saving of 2.5 per cent. in fuel; between 9 and 11 per cent. the saving due to an increase of 1 per cent. in CO_2 is 2 per cent. in fuel economy; and between 11 and 14 per cent. CO_2 the saving in fuel per unit increase in CO_2 is 1 per cent.

With the same flue-gas temperature, doubling the CO_2 percentage will reduce the fuel loss due to excess air by one-half. For example, with 6 per cent. CO_2 and a flue-gas temperature of 600 deg. F., the loss up the stack is 34 per cent. By increasing the CO_2 to 12 per cent., with the same flue-gas temperature, the loss will be 17 per cent. Actually, the gain is greater because increasing the CO_2 reduces the flue-gas temperature when the boiler load remains the same.

Every 25 deg. F. reduction of flue-gas temperature when the CO_2 percentage is 12, will effect a saving of 1 per cent. in the fuel bill and when the CO_2 is 6 per cent., the saving is twice as great, or 2 per cent.

Loss from Uncovered Steam Pipes

With reference to uncovered steam pipes it can be assumed that every square foot will cause a loss of one-half ton of coal per year. Therefore with 100 sq. ft. of uncovered pipe and the plant operating 365 days a year, the loss will be 50 tons of coal, which at the usual cost of coal, represents quite a substantial sum.

Every 10 deg. F. increase in feed-water temperature means a saving of 1 per cent. in coal provided the water temperature is raised by otherwise waste heat.

Taking the steam engine, generally speaking the higher the steam pressure and the lower the back pressure the greater the economy. This statement of course has its limitations, but they do not enter into ordinary everyday operation. By raising the steam pressure from 75 to 100 lb. gage, the steam consumption will be reduced 7.5 per cent. By increasing it another 25 lb. there will be a further reduction of 4 per cent. and by raising the pressure still higher there will be an additional gain but the saving will become proportionately less as the pressure increases.

Back Pressure More Important than Initial Steam Pressure

A more important factor than initial steam pressure is the back pressure. Every pound reduction in the back pressure above the atmospheric line means a saving of 1.5 to 2 per cent., depending on the type of the unit. Below the atmospheric line it can be assumed that between 0 and 10 in. of vacuum, the gain for each inch is 2 per cent.; between 10 and 20 in., the gain for each inch is about 0.8 per cent., and from 20 in. on, even less. This holds true with reciprocating engines only, and even with them it will depend upon a number of factors such as cylinder ratio, for example. With turbines the gain instead of decreasing will increase with each inch of improvement in vacuum.

With the ammonia compressor, low condenser pressures and high suction pressures count. This is exemplified by the exaggeration that if the condenser pressure could be brought down and the suction pressure raised to such a point that both would be alike, then no power would be required to operate the compressor, except that necessary to overcome friction. This, of course, is impossible, but there are many engineers who do not realize the importance of bringing together these two pressures as closely as operating conditions will permit.

Every 5 lb. reduction in condenser pressure means a saving of 2 per cent. in compressor power required, so that a reduction in condenser pressure of 20 lb., which very often is possible, would meam the saving of 8 per cent. of the steam used by the compressor engine.

Increase of Suction Pressure More Important Than Equal Reduction of Condenser Pressure

Increase of suction pressure is more important than an equal reduction of condenser pressure. Every pound of increase in suction pressure at the compressor will reduce by 2 per cent. the compressor power required per ton of refrigeration. In other words, an increase of 4 lb. in suction pressure is equal to 20 lb. reduction in condenser pressure.

These are average figures, but can be used to good advantage. As the range of suction pressure increases, the saving per pound becomes less, and in the case of condenser pressure a reduction from 240 to 230 lb. will not mean so great a saving as from 160 to 150 lb. Of course, the reduction at the higher pressure is easier to get and is obtained with less expenditure for auxiliary power, because the cost of pumping cooling water must be taken into consideration.

In reducing condenser pressures it should be borne in mind that improper distribution of water over the cooling tower may eventually cause a loss of 5 per cent. of the fuel. Good towers will cool water for the ammonia condenser down to 3 to 5 deg. F. of the wet bulb. Very often, when the condenser is blamed for poor performance, the actual reason is improper or improperly operated cooling towers.

Another important factor is the temperature of the liquid at the expansion valve before injection into the evaporating system. The liquid temperature should be within 3 deg. F. of the coldest water available in the plant. The saving in refrigeration is 2 per cent. for each reduction of 5 deg. F. in temperature.

The temperature of distilled or raw water also should be down to within 3 deg. F. of the coldest available circulating water before it is allowed to enter into the forecooler. The saving here is 1 per cent. for every 2 deg. F. reduction in temperature.

Another item worth remembering is that the ice plants should be so designed that the auxiliary power required will not exceed ½ hp. per ton of ice manufactured. Often as much as 1 hp. is used and developed by the most uneconomical means.

With few exceptions ice plants are uneconomical. Simple plants, instead of producing 5 tons of ice per ton of 10,000 B.t.u. fuel, produce 1½ to 3 tons on the average per year, and the reason is that the small savings possible here and there throughout the plant are disregarded.

Handling Superheaters During the Starting-up Period

By F. C. Torrance

The question of flooding superheaters during the starting-up period of putting the boiler "on the line" has had a great deal of discussion. At the beginning the theory was that the superheater tubes should be filled with water while the boiler was being started up in order to prevent burning out the tubes. This theory would probably still hold true if it were customary to put a blazing hot fire under a cold boiler and rush it onto the line. This, fortunately, is not the case. The practice in large stations has gradually been to draw away from flooding superheaters until now some stations do not even supply flooding pipes for the superheaters. In at least one instance it was proved that flooding did damage and not good. The superheater in question was of the double-loop type; that is, the steam was admitted to one header and passed through one set of tubes to a smaller header, which was attached to a similar header by short nipples. Thence it returned to the outlet header through a second set of tubes. The practice was at the start to flood the superheater. Trouble occurred after a time with leaks around the nipples connecting the small headers. These leaks appeared around the nipples where they were expanded into the upper header. One of the theories advanced for these leaks was that all water could not be drained out of the upper header and that it lay around the nipples in the upper box, thus causing unequal expansion. From then on the superheaters were not flooded in that station.

There are superheaters on the market that have, to the writer's knowledge, never been flooded. These are of the type that have cast-iron shroud rings around the tubes. The rings, of course, protect the tubes during the starting-up period.

Superheaters that are not flooded should be equipped with a drain so that they may always be blown out. On starting a boiler up after it has been cold, the drain should be opened. This will produce a tendency for the first vapor that is given off from the water in the boiler to pass through the superheater and prevent any chance of overheating the tubes. It will also blow out any water that may have condensed in the tubes. On bringing a boiler onto the line after it has been banked, it is a good thing to open the drain valves from the superheater to be sure that there is no water in the tubes.

If the superheater is not flooded, the danger of cutting the boiler in on the line without first draining the superheater is removed. This is a point that is of course up to the operating man, and in this way the human equation is removed. Another point in favor of not flooding the superheaters is the amount of pipe and valves that are saved. This is a relatively small item, but should be considered.

Another thing that should be carefully watched in all boiler plants is the setting of the superheater safety valves. These should always be set to pop first. In this case, if the station loses its load for any reason, there will always be a flow of steam through the superheater. There have been instances when no damage resulted when the safety valves on the drum popped first. The writer saw a very clear case of this when a calorimeter had been placed on the line from the drum to the superheater in order to determine the amount of moisture being carried over from the drum. This calorimeter was equipped with a recording thermometer. It happened that the load on the station was dropped at a time when the boiler in question was working at approximately 300 per cent. of rating. This caused the safety valves to pop, and the drum valves let go, first taking care of the boiler output so that there was a comparatively small amount of steam passing through the superheater, as was proved by the fact that the temperature in the line from the drum to the superheater rose to such an extent that the recording thermometer on the calorimeter was damaged. This was caused by superheated steam backing into the drum from the superheater. While there was a small amount of steam passing through the superheater to take care of the station auxiliaries at this time, by far the largest amount was being discharged through the safety valves on the drum, and yet no damage resulted to the superheater. While this is not a good practice, it is mentioned here to show that superheated tubes will not as a rule be damaged in extreme cases as long as a small amount of steam is passing through them.

In summing up, it seems that superheaters can safely be used without flooding. All precautions should be taken, however, to insure safety. Drain lines should be installed and used when starting up a cold boiler or when bringing a boiler onto the line from a banked condition. The safety valves on the superheaters should be set so that they will pop before the valves on the drum. If these precautions are taken there can be very little if any damage done to the ordinary installation of superheaters.

Heating System Vacuum*

By D. N. CROSTHWAIT, Jr.

This article deals with heating systems in which the steam is circulated at atmospheric and greater pressures. The argument shows that a high vacuum in the return piping of a heating system requires a larger amount of power to operate the vacuum pump.

WHAT degree of vacuum should be carried in the return piping of a vacuum heating system is something on which many engineers operating such systems seem to disagree. From 8 to 10 in. is the degree of vacuum most ordinarily maintained in practice, while as high as 20 in. and as low as 2 in. are often found.

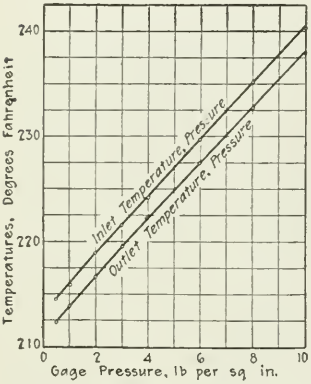


FIG. 1. CURVES OF INLET AND OUTLET PRESSURE

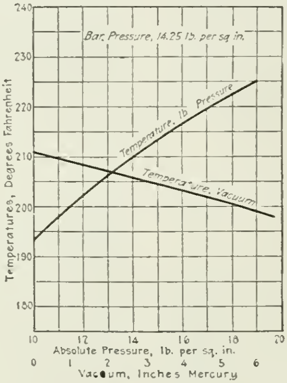


FIG. 2. TEMPERATURE PLATTED AGAINST VACUUM

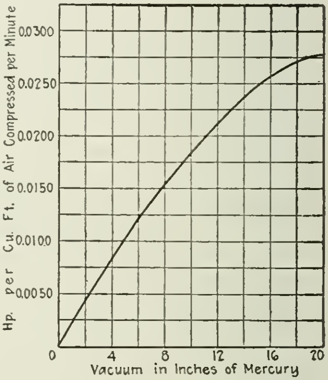


FIG. 3. INCREASE OF H.P. CONSUMPTION PE RINCREASE OF

Upon consideration it will be remembered that with the ordinary vacuum heating system the vacuum is generally maintained in the return line only, while the steam pressures carried may vary anywhere between 1 and 10 lb. gage, although, at times the steam is circulated at less than atmospheric pressure. Such cases, however, are comparatively rare, and for this reason the following will deal more particularly with the case where the steam is circulated at pressures varying from atmospheric to greater ones.

It is often noticed that no difficulty is experienced in obtaining a moderately high degree of vacuum in the return piping of a vacuum heating system when the steam pressure carried on the radiators and in the steam piping is low, and that an increase in steam pressure results in a reduction of the vacuum. In discussing the reason for this a number of factors must be taken into consideration.

A trap of some sort is generally used on each radiator in vacuum steam-heating practice. The purpose of this trap is to free the radiator from air and water while retaining the steam. If the traps did not prevent the steam from the radiators entering the returns, it would not be possible to produce a vacuum in the return piping without the use of a condenser of some kind. In former years the use of condensing water in the returns of vacuum steamheating systems was looked upon with favor, but its use is becoming less frequent, because of the many disadvantages connected therewith and the obviation of its use by the commercially successful thermostatic radiator trap. With such a radiator trap of proper design the outlet temperature, or the temperature of the water released by the trap, will bear a definite relationship to the steam pressure in the radiator.

It is a known fact that an increase in steam pressure is accompanied by a rise in the steam temperature. The temperature of the steam in the radiator will vary with the steam pressure, consequently an increase in the pressure of the steam in the radiator will result in an increase in its temperature. Then, if the outlet temperature of the trap bears a definite relation to the steam temperature or pressure, the outlet temperature will increase in the same proportion as the steam temperature increases. Or, in other words, the temperature of the water entering the return piping will increase as the pressure increases.

For example, in Fig. 1 two curves are plotted. One is the outlet temperature obtained in some radiator tests plotted against the steam pressure existing at which the outlet temperature was obtained; the other is the temperature of the steam entering the radiator at these same pressures. Each point on the curve represents the average temperature obtained at the average pressure maintained for a given period in a series of tests made on a thermostatic trap. These curves show clearly the variation of temperature with pressure variation in a radiator under the given conditions.

Since the boiling temperature of water depends upon the pressure upon it, the reduction of the pressure upon the water means the lowering of its boiling point, the difference in the heat of the liquid between the two boiling points serving to vaporize a part of the liquid. As the vacuum in the return line becomes greater, the

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temperature at which the water contained therein will boil becomes less. With an atmospheric pressure of 29.1 in. of mercury and a vacuum of 5.6 in. prevailing in the return line, the water will boil at a temperature of about 200 deg. F., provided it does not lose enough heat to prevent it. Similarly, with the atmospheric pressure remaining the same, an increase of the vacuum to 10 in. would lower the boiling point to 190 deg. approximately. Thus it is evident that if water at a temperature higher than that corresponding to the pressure is released into the return line, it has a tendency to increase the pressure therein to that corresponding to its temperature. Hence, there is a tendency for the vacuum in the return line to decrease as the pressure increases and a decrease in the vacuum under such circumstances is no sign that there is steam leakage into the return piping.

For example, if water at 200 deg. F. is discharged into a return line in which a vacuum of 10 in. of mercury exists (atmospheric pressure being the same as in the foregoing), the heat of the liquid will be 167.94 B.t.u. per lb. Under the same atmospheric pressure the heat of the liquid for a 10 in. vacuum is 157.91 B.t.u. per lb. which gives an excess of 10.03 B.t.u. per lb., which will serve to vaporize a part of the water. The vacuum existing in the return pipe remaining the same, an increase in the temperature of the water entering it will result in an increase in the heat of the liquid available for reëvaporation. Also, with a given temperature of the water entering the return line, an increase in the vacuum carried will result in an increase in the heat of the liquid available for vaporization. So, if conditions are not such that the water entering the return piping will have the excess heat dissipated, the loss of a certain amount of vacuum will result. This is clearly shown by Fig. 2.

Aside from the variation of the steam pressure, it should be noted that there are a number of factors that affect the vacuum obtainable in the return piping of a vacuum heating system. Among them are air leakage, the facilities for dissipating heat and the capacity and condition of the vacuum pump. The effect of these will vary with every installation. Generally speaking, the degree of vacuum obtainable will increase as the ability to dissipate the excess heat increases, other conditions being equal. Thus with returns uncovered a greater degree of vacuum is obtainable than where they are covered, or where the returns run through a cool basement as against a hot basement. In either case the vacuum obtainable will decrease with the increase of the steam pressure.

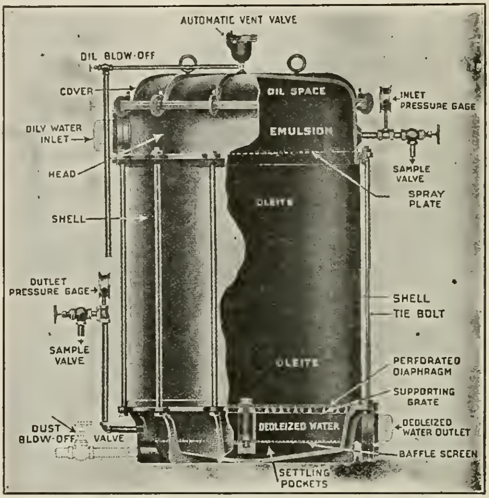
The reason for maintaining a vacuum in the return piping of a heating system is to maintain complete circulation of the steam throughout all of the heating units at the steam pressure for which the system of heating was designed. This is a low pressure, generally not over 2 lb. gage, and the vacuum is maintained so as to provide for the circulation of the steam throughout the system by maintaining a sufficient differential to permit the removal of water and air from the radiators.

The power consumption of a vacuum pump increases as the vacuum increases, provided the head it discharges against remains constant. This is clearly shown by Fig. 3.[1]

Since the maintenance of a high vacuum in the return piping of a heating system requires a large amount of power to operate the vacuum pump, a reduction in the temperature of the water handled by the vacuum pump—which means a lowering of the temperature of the water used for boiler-feed purposes or discharged by the vacuum pump to the feed-water heater—and moreover, since increasing the degree of vacuum beyond a certain point has little effect on the pressure of the steam in the heating units, it is evident that the desirable vacuum for most cases is the lowest at which complete circulation of the steam can be maintained with the given steam pressure.

Oily Condensate Deoleizer

The elimination of cylinder oil from the emulsified return from a heating system or the condensate from a surface condenser is a difficult problem, but is desired by all engineers. If oily returns are freed from the emusified oil, a saving in feed water by using the returns instead of wasting them will be made, a saving in coal by saving the heat units in the return will be possible, and a boiler free of oil will be assured.



SEMISECTIONAL VIEW THROUGH THE DEOLEIZER

To do this a device known as the Deoleizer has been developed by the Oleite Corporation, 95 William St., New York City. This apparatus does not depend upon the chemical straining out of oil as it passes through a filtering material, etc., but upon the absorption property of a mineral substance of cellular structure called "oleite." The type of apparatus described herewith consists essentially of four principal parts—the base, the shell, the head and the cover. It is divided into four spaces by perforated diaphragms. The oily returns of condensate enter near the top through a flanged nozzle, and the deoleized water leaves near the bottom through a similar nozzle.

If the returns contain any free oil upon entering the head, it rises and accumulates in the oil space in the cover, out of the way of currents. The free oil can be drawn off as required, at the oil flow, and used again if desired. The oleite, with an intermediate cloth screen, rests on a diaphragm of noncorrodible metal perforated with fine holes very close together. It is supported by a cast-iron grating filled with large circular holes to allow a free exit of the purified water. This grating is necessary in order to support the weight of the oleite. The diaphragm rests on rounded knobs projecting above the grating. Any fine particles of oleite that may accidentally pass the perforated diaphragm sink through the dead-water space in the base and drop through a closely perforated baffle-screen in the settling pocket below, where they are out of the current and can be blown off. The cover is packed on the head with a rubber tubular packing and is bolted in place.

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[1] The curve in Fig. 3 is plotted from data given in Vol. II, of Harding and Willard's "The Mechanical Equipment of Buildings."

The oleite has an affinity for oil and its derivatives, and as the water passes through the bed of oleite the oil is absorbed by it and the water passes to the bottom in a refined state. Low-pressure gages and sample valves are fitted to the head and base respectively. The difference in reading on the gage indicates when the oleite is becoming unduly clogged. This will happen at intervals of anywhere from one month upward, depending upon the amount and character of the oil. To clean, remove the cover and spray the plate, take out the oleite down to the cloth screen, and replace with new oleite. The saturated oleite can be made ready for use again by burning the oil of it, which makes it as good as new.

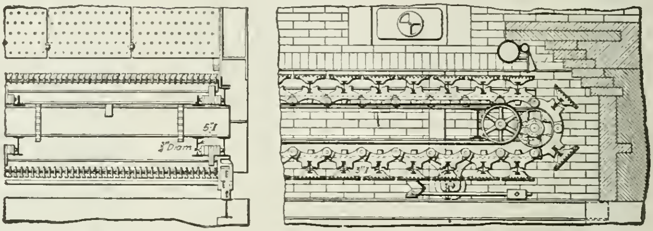
Shutting off Excess Air Through Traveling Grate

Motorcycles are turned out in large numbers by the Excelsior Motor Mfg. & Supply Co., Chicago. In the manufacture of these machines there is need of considerable electrical energy for power and lighting and steam for process work. These services are rendered by a private plant consisting of two 480-hp. water-tube boilers equipped with traveling grate stokers. Steam is supplied at 150 lb. pressure. There is a conveyor system to handle the coal, overhead bunkers and automatic scales to weigh it. A steam jet vacuum system disposes of the ash. In the engine room there are two generating units consisting of 220-volt direct-current machines driven directly by Corliss engines. One unit is rated at 300 kw. and the other has one-half this capacity.

At the present time the load averages, 400 kw., for 11 hr. per day and in addition steam is supplied for process work. At one time it required the two boilers to handle this load and the efficiency was below normal. With Franklyn County "Spiralized" coal it was necessary to carry an 8-in. fuel bed the full length of the grate, and at periods of lighter load the fire could not be shortened without excessive loss.

Excess air passing through the grate and around the rear of the stoker was the cause of the low efficiency of combustion. Repeated tests with an orsat connected to the uptake showed that it was impossible to exceed 6 per cent. CO_2. To eliminate much of this excess air was the problem and the accompanying illustration shows how it was done.

To prevent excess air passing through the grate, particularly toward the rear portion, the engineer designed steel curtains, one on either side of the rollers and supporting structure at the center of the stoker, that were adjustable and could be set to seal off the dead portion of the fire at the rear. Each curtain consisted of 14 flat lengths of steel 4 in. wide, $\frac{3}{16}$ in. thick and 4 ft. 3 in. long, laid crosswise of the furnace between the upper and lower runs of the stoker, on ordinary link chain at either end, with lugs on each link to which the bars were riveted. The chains run over sprockets at either end of the stoker, and at the front the shaft runs through the four sprockets, with a ratchet handle at the end so that adjustment of the two curtains may be made simultaneously. The curtains fit snugly and make a good seal. Lengthwise of the stoker the curtains measure $14 \times 4 = 56$ in. They may be run forward or back over the rear sprockets, as desired, so that the fronts of the curtains may be set at any point of the grate, depending upon the length of the fire.



SHOWING AIR CURTAIN AND AIR BAFFLE APPLIED TO STOKER

To prevent air leakage around the rear of the stoker a series of cast-iron baffle hangers, properly ribbed to prevent warping, were mounted behind the waterback on a piece of piping with solid shafting inserted to make it rigid. Each hanger is about 5 in. wide and as the baffle extends all the way across the stoker, dragging on the dead ash, a good seal is effected.

With the two baffles in place a great improvement in results was noticeable. The best length of fire to meet the requirements of load and atmospheric conditions could be carried. With the same fuel and a load greater than before a fuel bed 4 in. thick proved sufficient. The CO_2 jumped to 14 per cent. and was maintained continuously within the range of 12 to 14 per cent. More rapid steaming is particularly noticeable. A big factor in the saving is that one boiler now carries the load.

At the present writing the daily coal consumption averages 9 tons and to carry the peak load in winter rarely exceeds 12 tons. Formerly with a smaller load, the daily coal consumption ranged from 15 to 20 tons, the higher figures indicating the winter peak load. A conservative estimate indicates a saving exceeding 5 tons of coal per day.

An electric power company is not liable for death of a boy who, by climbing a tree, came in contact with a wire carrying a dangerous voltage, where the wire was thirty feet above the ground, unless it be determined that the wire was so situated that an ordinarily prudent person would have foreseen such an accident. (California Supreme Court, Minter vs. San Diego Consolidated Gas and Electric Co., 182 Pacific Reporter, 748.)

The Electrical Study Course—Power in Polyphase Systems

Comparison is made between the voltage and current per phase in the line conductors and that for the load in both two- and three-phase systems, and then it is shown how to calculate the power in polyphase systems.

IN ORDER to understand the relations between voltage, current and power in two- and three-phase systems, it is necessary first to consider the relations between the currents and voltages of the load and those of the lines.

In Fig. 1 is represented a two-phase four-wire system. The current in the lines *A* and *B*, as indicated by the ammeter A_1, is obviously the same as that flowing through the load L_1, and similarly that through L_2 is the same as the current indicated by ammeter A_2. If the loads are the same—that is, if the system is balanced—ammeters A_1 and A_2 will read alike. Thus, if L_1 takes 100 amperes, L_2 will take 100 amperes, and the readings of A_1 and A_2 will be 100 amperes each. If the line voltage as indicated by voltmeters V_1 and V_2 is 500 volts, the voltage of the loads as indicated by V_3 and V_4 will also be 500 volts.

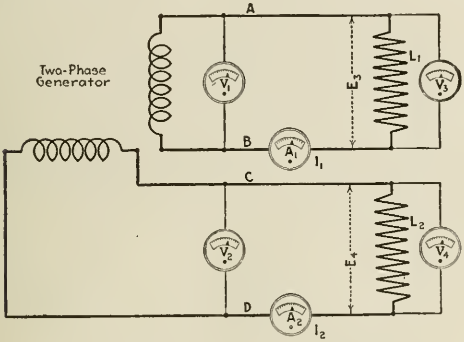


FIG. 1. FOUR-WIRE TWO-PHASE CIRCUIT

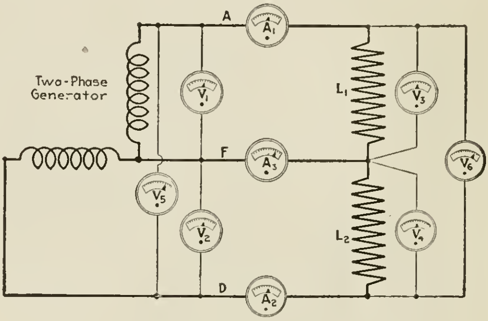


FIG. 2. THREE-WIRE TWO-PHASE CIRCUIT

If the loads of Fig. 1 are connected to the same system changed over to three-wire transmission, we have the arrangement shown in Fig. 2. In this case ammeters A_1 and A_2 again read the currents through the loads L_1 and L_2—namely, 100 amperes each—but A_3 reads the resultant of these currents, which for alternating currents 90 deg. out of phase will be equal to $100 \times 1.414 = 141.4$ amperes—the reading of ammeter A_3. The voltmeters V_3 and V_4 will read the same as V_1 and V_2—namely, 500 volts—and V_6 will read the same as V_5, whose reading will be $500 \times 1.414 = 707$ volts.

In Fig. 3 we have three equal loads connected delta to a three-phase system. Assume that the loads take 100 amperes each; then ammeters A_4, A_5 and A_6 will each read 100 amperes. The current in line *A* will be the resultant of that in L_1 and L_2, which for currents 120 deg apart will be $100 \times 1.73 = 173$ amperes. The currents in lines *B* and *C* are the resultants of L_2 and L_3, and of L_1 and L_3 respectively, so that each of them also is equal to 173 amperes. Hence ammeters A_1, A_2 and A_3 will all read the same. The voltages across L_1, L_2 and L_3 are the same as those across lines *AC*, *AB* and *BC*. Hence, if voltmeters V_1, V_2 and V_3 read 500 volts, V_4, V_5 and V_6 will likewise read 500 volts.

In Fig. 4 we have the three loads of Fig. 3 connected "Y" instead of delta. In this case the currents in lines *A*, *B* and *C* are the same in value as those through loads L_1, L_2 and L_3 respectively, and therefore ammeters A_1, A_2 and A_3 will read the same as A_4, A_5 and A_6; namely, 100 amperes. If the voltage registered by voltmeters V_4, V_5 and V_6 is 500 volts each, that registered by V_1, V_2 and V_3 must be $500 \times 1.73 = 865$ volts, since V_1 is the resultant of V_4 and V_6, V_2 the resultant of V_4 and V_5 and V_3 the resultant of V_5 and V_6 at a 120 deg. phase difference. The foregoing result gives us the following facts:

In a two-phase four-wire system the line current equals load current and the line voltage equals the load voltage. In a two-phase three-wire unbalanced system the current in the outside lines equal the load current, the current in the middle line equals load current times 1.414, and the line voltage equals load voltage.

In a delta-connected three-phase system the line current equals load current times 1.73; line voltage equals load voltage. In a three-phase system "Y" connected the line current equals the load current and the line voltage divided by 1.73 equals the load voltage.

From the previous lesson we found that the apparent power, volt-amperes, equals the voltmeter readings times the ammeter readings, and the true power, watts, equals the volt-amperes times the power factor. The apparent power in Fig. 1 will be $v.\text{-}a. = (E_3 \times I_1) + (E_4 \times I_2) = (500 \times 100) + (500 \times 100) = 100{,}000$ volt-amperes. That in Fig. 2 will be the same. In Fig. 3 the apparent power will the $v.\text{-}a. = (E_4 \times I_4) + (E_5 \times I_5) + (E_6 \times I_6) = (500 \times 100) + (500 \times 100) + (500 \times 100) = 150{,}000$ volt-amperes. In Fig. 4 the power would be the same as that in Fig. 3. It will be seen that in a balanced two-phase system the total apparent power equals the volt-amperes of one phase times

2, and that in a balanced three-phase system the total apparent power equals the volt-amperes of one phase times 3. Hence, if the volts and amperes of one load are known, the entire load of the system can be determined. In many cases, however, the volts and amperes of the load cannot readily be measured, only those of the line being accessible. The question then arises, how are we to compute the power from the line voltage and line current? On first thought we might be inclined to say it is equal to twice the voltage times the current per phase in a two-phase system, and equal to three times the voltage times the current per phase in a three-phase system. The former of these conclusions is correct, but the latter would be erroneous. To prove the latter consider again Figs. 3 and 4.

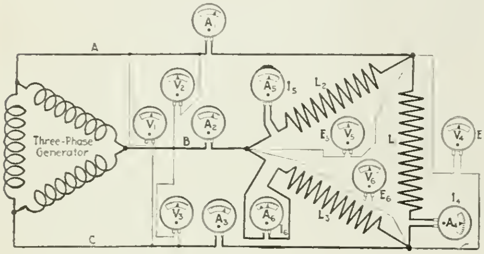


FIG. 3. DELTA-CONNECTED THREE-PHASE CIRCUIT

In Fig. 3 the line current was found to be 173 amperes and volts per phase 500. In this case, volts × amperes × 3 = 500 × 173 × 3 = 259,500. In the "Y" connection, Fig. 4, the line current was found to be 100 amperes and the volts between phases (lines) to be 865; then volts × amperes × 3 = 865 × 100 × 3 = 259,500 amperes. But the apparent power was found to be only 150,000 volt-amperes. If we divide 259,500 by 1.73, there is obtained an answer 150,000, which corresponds to the correct value of volt-amperes. This shows the line volts times the line current times 3 to be 1.73 times too great, which is what would be expected since the line current in a delta connection is that of one phase times 1.73 and the voltage between lines in a "Y" connection is 1.73 times that of one phase. The constant 1.73 is the square root of 3, therefore since the voltage in one case is increased by $\sqrt{3}$, and in the other case the current is increased by $\sqrt{3}$, the apparent power in a three-phase circuit will be equal to the line current times the volts between the lines times the $\sqrt{3}$ (1.73), or in Fig. 3 volt-amperes = 173 × 500 × 1.73 = 150,000, and in Fig. 4 volt-amperes = 100 × 865 × 1.73 = 150,000. Hence the apparent power of a balanced three-phase circuit is $v.\text{-}a. = EI \times 1.73$, where E is the voltage as measured between any two line conductors and I the current in amperes flowing in any one of the three line conductors.

The foregoing has not taken into consideration the power factor of the circuit. Whenever there is inductance in the circuit, which is generally the case, the power factor of a polyphase circuit must be considered as in a single-phase circuit, to obtain the true watts, and is applied the same way in both cases. In a two-phase circuit the true watt $W = 2EI \times P.F.$, therefore in Figs. 1 and 2 if the power factor is 0.80, $W = 2 \times 500 \times 100 \times 0.80 = 80{,}000$ watts. The true watts in a three-phase circuit will be $W = 1.73EI \times P.F.$ In Fig. 3 if the power factor is 0.80, the true watts will equal $W = 1.73 \times 500 \times 173 \times 0.80 = 120{,}000$, and in Fig. 4, $W = 1.73 \times 865 \times 100 \times 0.80 = 120{,}000$ watts. The power factor in a balanced polyphase system—two-phase or three-phase—is the same as for single-phase system; this is, *power factor* $= \frac{\textit{true watts}}{\textit{apparent watts}}$. There is no standard definition of what the power factor of an unbalanced polyphase system is. However, the question is now under consideration by the electrical engineering societies, and no doubt some standard will be adopted in the near future.

In the first problem given in the previous lesson, the reading of the voltmeter was given as 230, that of the ammeter 175 and of the wattmeter 35 kw., to determine the volt-amperes, kilovolt-amperes, power factor and the phase angle between the current and the voltage. The $v.\text{-}a. = EI = 230 \times 175 = 40{,}250$; $kv.\text{-}a. = \frac{v.\text{-}a.}{1000} = \frac{40{,}250}{1000} = 40.25$ kilovolt-amperes; and the power factor $P.F. = \frac{kw.}{kv.\text{-}a.} = \frac{35}{40.25} = 0.87$. Referring to a table of sines and cosines and finding an angle whose cosine is equal to the power factor, 0.87, will give the phase angle between the current and voltage. In this case it is found to be approximately 29 deg.; that is, the current is approximately 29 deg. out of step with the voltage.

In the second problem the power factor was given as 0.80, the wattmeter reading 75 kw. and the voltage 440, to find the ammeter reading, the volt-amperes, kilovolt-amperes and the phase angle between the voltage and current.

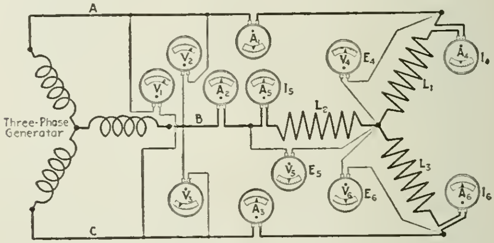
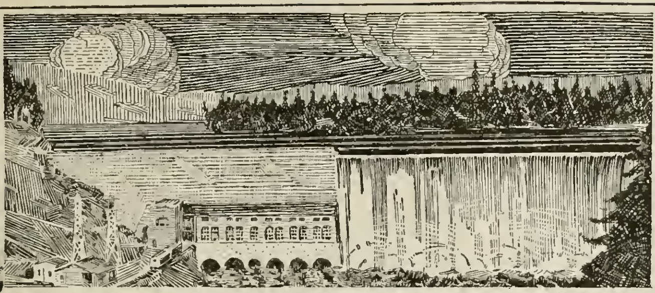


FIG. 4 STAR-CONNECTED THREE-PHASE CIRCUIT

The ammeter reading in a single-phase circuit, where the watts, volts and power factor are known is, $I = \frac{W}{E \times P.F.}$ In this problem $I = \frac{75 \times 1000}{440 \times 0.80}$ equals 213 amperes; kilovolt-amperes, $kv.\text{-}a. = \frac{kw.}{P.F.} = \frac{75}{0.80} = 93.75$. The phase angle between the voltage and current in this problem can be found the same as in the previous one, by referring to a table of sines and cosines and finding an angle whose cosine is equal to the power factor, 0.80. This angle will be found to be approximately 37 degrees.

The ammeters in the lines of a 600-volt three-phase system each indicate 400 amperes. The power factor of the system is 78 per cent. The load is connected delta. Determine the power furnished to the load, voltage and current of each leg of the load. Determine the foregoing quantities when the load is connected "Y" and has a power factor of 72 per cent., assuming the same line voltage and current as in the foregoing.



POP'S WATER-POWER COURSE

By
John S. Carpenter

"JES' hand me that drawin' board with them compasses an' pencils," said the old chief. "Tonight we sees how they finds the number of buckets they puts on them there Pelton wheels we've been a-studyin' about, an' a few other little things." With a significant glance, he added, "An' they don't do it by throwin' up a coin or shootin, any craps over it, either."

"Here's your tools."

"Fig. 1 shows how they finds the theoretical spacin' of the buckets. This time we'll confine our argyments to a wheel 18 in. in diameter on the stream line an' havin' a 2-in. stream or jet. That jes' makes a ratio of 9, an' you'll see that the stream is set in from the outside of the wheel to the center line jes' 2.6 in., the same bein' 1.3 times the diameter of the jet. The diameter bein' 18 in., an' addin' to that twice 2.6 in. gives us an over-all diameter of 23.2 in. Now, this is a pretty low ratio wheel, an' in such a case we likes to reduce the speed a little on the stream line so the speed on the outside of the wheel ain't too high. So we uses 45 per cent. of the spoutin' velocity on the stream line, which gives us 50 per cent. on the outside of the stream or 58 per cent. on the outside of the wheel. I might say here, to forestall any pile drivin', that this 58 per cent. is a bit high, but it won't cause any trouble if they is buckets enough and the outside end of 'em is lengthened out a bit so the tail end of the cut-off portion of the jet gits a little time to react. Drawin' this to scale, we can measure distances down to a gnat's eyebrow an' avoid figgers almost altogether. Drawin' in the circle tangent to the outside of the stream, we begins at the vertical center line an' spaces off some small distances about half an inch long, no partic'lar length bein' needed, only we must remember to stick to that distance once we make it. Number these spaces on the circle 0, 1, 2, 3 an' 4. Very well, that's done. Now from the center line at 0 start an' lay off equal horizontal distances as shown by the points *a*, *b*, *c*. The spaces on the circle is the distances the wheel would move in a very short time, and the spaces on the horizontal line is the distances the stream would travel in the same time that the wheel takes to go them small spaces 0, 1, 2, etc. On the outside of the stream I told you the wheel speed is 50 per cent of the stream or jet speed, so them last spacin's must be jes' twice as long as the circular spaces. See?"

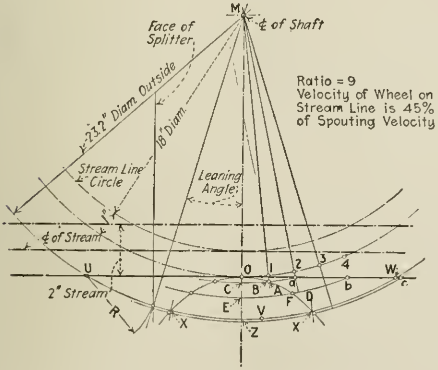


FIG. 1. SHOWING THE METHOD OF FINDING THEORETICAL SPACING OF THE BUCKETS

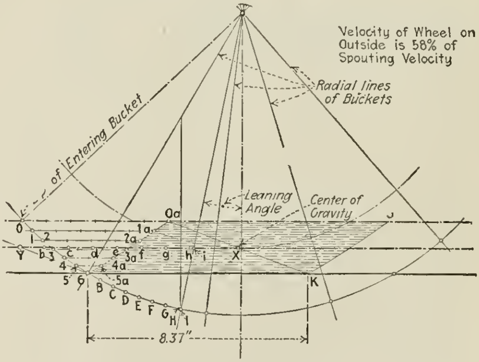


FIG. 2. SHOWING HOW STREAM IS CUT AND GRAPHICALLY FINDING LEANING ANGLE

"You mean because the water travels twice as fast as the wheel?"

"Yep! Now then, swing circles around through them points *a*, *b* an' *c* with *M* as a center. Next, draw radial lines from *M* through them points 1, 2, 3, cuttin' the circular arcs to which they belongs at places *A*, *D*, etc. Now the distance from *C* to *A* is the amount the wheel will move while the water moves from *C* to *a*, leavin' the small piece from *A* to *a*, this bein' the relative velocity of the water with respect to the wheel, or the difference in speed between the water and the wheel. In the same way the distance *D* to *b* is the relative velocity at point *b*. Lay off these distances from the center line *MZ*, which gives you *C* to *B* an' *E* to *F*, an' do the same with the outside circle on point *c*. Now hand me that French curve over there."

Pop carefully fitted the curve to the three points he had located and also the tangent of the circle at *O* and drew in the curve *O* to *X*. Then the curve was turned over and the other half drawn in, giving the irregular curve *XOX*, cutting the arc of the outside of the wheel as shown.

"Now," said the old chief with an air of triumph, "they don't dare space them buckets any farther apart than from *X* to *X*, measured on this here curve. Measurin' the distance around, it is jes' 5.5 in., which, divided into the circumference of the circle, the same bein' 23.2 x 3.1416 = 72.8 in., gives 13.22 buckets theoretical. To prevent water slippin' by the wheel unused, they usually allows from 15 to 20 per cent more, which in this case would give us 15 buckets, since it is a high-speed wheel an' we'll have trouble enogh to git 15 bukets on the wheel, well fastened. In a little bit I'll come back to the subject of water slippin' by the wheel unused."

"I think I get your explanation of the method, Pop, but there must be another way of finding the spacing, too." Jimmy pointed his cigar at a rakish angle and bent over Pop's drawing. "Now follow me. Suppose, Pop, we have a bucket at *U* and a drop of water starts away from *U* at the same time the bucket edge does. If the space was clear, the drop of water would tend to go clear across to *W*, and then it would be beyond the influence of the buckets. Since the bucket moves at 58 per cent of the water velocity, for every inch that the water drop moved on the horizontal line, the bucket would move 0.58 in. around on the circular arc. I measure the horizontal line *UW* to be 11.75 in. long, and the distance around on the circle as"—Jimmy painfully stepped off the distance around on the arc between *U* and *W*— "12.32 in. During the time that the water moves from *U* to *W*, which is 11.75 in., the bucket lip or edge moves 58 per cent of this, or 6.82 in., and deducting that from your circular arc length, 12.32 — 6.82 = 5.5 in., the same as you got with all your fussing with curves!" Jimmy glanced teasingly at the dazed and crestfallen Pop.

"You mean," began Pop quite apologetically, "that you must have a bucket at *W* to catch the last drop there, don't you? You only said your bucket got to the place marked *V* an' then you hopped to a conclusion, like a woman's reason—'because.'"

"Of course, Pop, I'll gladly give you credit for that, and I'll also say that your method is quite a bit more handsome."

With his composure and gravity quite recovered, Pop cleared his throat and brought up the heavy artillery. "Now, young feller, do you see that point *O*, on the vertical center line? Well, there the water is strikin' the bucket right parallel to the direction of its rotation. It doesn't matter where I draws in the curve, whether it is at *U* or at *O;* I jes' drew it in at *O* 'cause there I could show you, like the lecturer showed me, that the water strikes the bucket square. Now it's plain that when the water strikes the bucket square, it should be at right angles with the stream at that place. So you takes the distance *X* to *Z* on your compass an' strikes the arc *R* from *U* as a center. Drawin' a radial line to the center *M* of the wheel, we gits the angle that the bucket should lean, the same bein' called the leanin' angle. Therefore the old rule of thumb that Pelton wheel designers allers used, that the leanin' angle should be half the angle between two buckets. Where we uses more than the theoretical number of buckets, you take, of course, half of the angle correspondin' to the number that you uses.

"Like you showed me on your idee of findin' the bucket spacin', you can find the leanin' angle, too—only a little different. Glue your lamps to Fig. 2 for a spell! This shows us how the stream is cut by the lip of the enterin' bucket. A drop of water at the top of the stream at *O* moves to *0a* while the bucket moves through the stream, an' in the same way a drop at v moves to *1a* while the bucket moves to 6. Followin' 'em all out thataway, you gits the points *(0a, 1a, 2a, 3a*, etc. to *6*. Then drawin' in the curve through these points, you gits the shape of the cut. Now to git the length of the slug of water. We figgered to use 15 buckets on the wheel, which brings 'em 4.86 in. apart measured on the circle. Since the wheel moves 58 per cent. as fast as the water, divide 4.86 by 0.58 an' you gits 8.37 in., the length of the solid slug. At the end of the slug you can draw in the same curve *JK* that you drawed in at the beginnin', and then you has the exact shape of the thing. Now, draw a diagonal line cuttin' the center line of the stream at *X*. This place is the center of gravity of the slug and corresponds to the point *O* in Fig. 1. Now, to show how it works, I'm a-goin' to transfer the point *X* to the next slug comin' along, which is then at point *Y*. Rememberin' that the wheel moves jes' 58 per cent. of the water velocity, an' considerin' the bucket lip to be at *6*, we'll

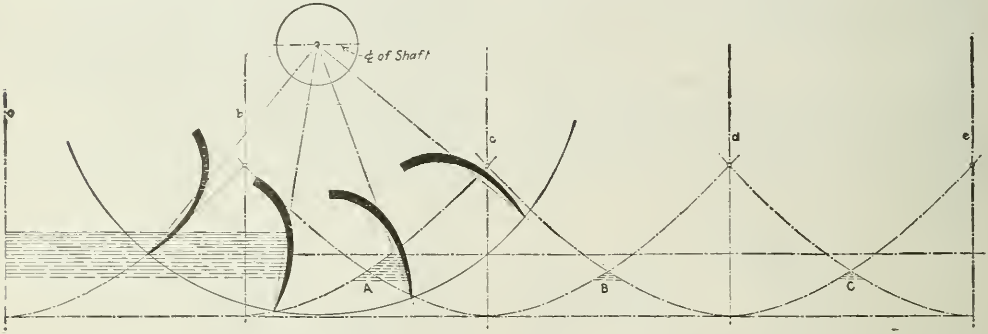


FIG. 3. SHOWING SECTIONS OF JET ESCAPING UNUSED DUE TO TOO FEW BUCKETS

go ahead. While the drop of water at Y moves to *b*, the lip has moved from *6* to *B*, an' so on until the bucket lip gits to *H* on the straight line an' to *h* on the curve. At that place they is still a wee piece until the drop of water at *Y* would touch the radial line of the bucket lip, and proportionin' the distance between the two points we're jugglin', you sees the point *Y* overtakes the radial line at point *i* on the curve. Now if you'll jes' measure around the curve from *6* to *I*, you'll see that it is so close to one-half the distance from *X* to *X* in Fig. 1 that they's no fun in it. In real scrappin' this method is not exactly right, 'cause most designers argues that the bucket should be set square with the stream when the center of gravity is at the bottom of the curve of the bucket while others says it should be at the discharge edge of the bucket. So you sees they's plenty of room for a good scrap. However that may be, I thinks it should be at the bottom of the bucket, but the facts is that most designers makes the leanin' angle half the angle between two buckets an' lets it go at that, 'cause a few degrees one way or t'other ain't gonna kill the efficiency." Pop looked at Jimmy expecting a flare-back. "You look like you gonna say somethin' mean in a minute, so spit it out!"

"No, Pop, nothing mean; I'm just thinking that you once told me that the analytical design of Pelton wheels is complicated. I believe you told the truth."

"I said awhile back that I was gonna return to the subject of water gittin' through the wheel without doin' useful work. Now, son, they's oftentimes in power-plant operation when heavy load changes occurs an' when the wheels speed up quite a bit if the load goes off. For full load off, the changes in speed, especial if they's a long pipe line or the velocity of the water in it is high, then you can't use a quick-acting governor. In sich cases the speed may go up 20 to 25 per cent, which is the same at those speeds as if the wheel didn't have enough buckets on it. Then the water is gonna slip through and spatter on the housings of the wheel like machine-gun fire. If the water is under high head, it will dern soon begin to wear through the cast-iron or steel housings an' raise the divil in general. The same dope applies to a wheel designed with too few buckets for its normal speed. On Fig. 3 I shows you a case where only 12 buckets was used an' accordin' to our figgers, we should have 13.22 buckets theoretical. You'll wanta know how I got that bucket curve. Well, I just forgot that the stream was any particular size and extended the method used to find the outline of the ends of the slug in Fig. 2, indefinitely. Them vertical lines *b*, *c*, *d*, etc., is just the length of the slug apart, in this case bein' 10.5 in. For every bucket that goes through the stream, a small part like *A*, *B*, *C*, etc., goes through unused. When you figgers that they's maybe 4000 of 'em per minute, you'll soon see that this means loss in efficiency. Then, besides the loss in power they's a lotta racket with all that water goin' agin' them housin's. It would give me the jimjams sure as blazes!"

Under the Federal law, which declares that it shall be unlawful to use a locomotive in moving interstate traffic unless the boilers and appurtenances are in proper condition, a railway company or its receivers are liable for the death of an engineer in a boiler explosion due to defects in the bolts and stays designed to sustain the crown-sheet. (Texas Court of Civil Appeals, Lancaster vs. Carroll, 211 Southwestern Reporter, 797.)

Steam Boiler Policies Interpreted

By A. L. H. Street

A policy carried by plaintiff company with defendant insurance company indemnified the former against loss on account of the explosion of seven vertical-tube boilers used in a power plant at Ithaca. A clause in the contract provided that the term "boiler" in the policy should "mean any receptacle or vessel enumerated and described" in the contract "as such, in which steam is generated or used, and shall include the steam, feed and blowoff piping to and including the stop valve nearest the boiler in any of such piping, also the water column, safety valve and all steam and water gages." Other parts of the contract indicated that the boilers insured against explosion were intended to include only the seven boilers proper.

An explosion, causing great damage, occurred in an economizer connected with boilers Nos. 1 and 2. The defendant resisted liability under the policy and suit followed. A jury returned a verdict in favor of the plaintiff for $25,000, but the New York Supreme Court has reversed the decision, holding that, since the economizers were merely used to heat the water before passing it to the boilers proper, they are not to be regarded as covered by the policy. It is also held that a valve between the boilers proper and the economizers, shutting off the flow in either direction, was a "stop valve," within the meaning of the clause of the policy referred to, extending the insurance "to the stop valve nearest the boiler." Further reason for excluding an economizer as a "boiler" is found in the fact that the policy specified that the word "explosion" should cover a "collapse of the boiler . . . or its flues." (Ithaca Traction Co. vs. Travelers' Indemnity Co., 177 New York Supplement, 753.)

Safeguarding Employees Against Injury

By A. L. H. Street

The Texas Supreme Court has affirmed a judgment denying the right of an engineer employed in an electric power plant to recover damages for injuries sustained when he tripped over a wrench on a floor, thereby causing him to fall against the frame of an exciter and his hand to enter the machine. (Taylor vs. White, 212 Southwestern Reporter, 656.)

The plaintiff unsuccessfully based his claim on the grounds that the defendant, as receiver of the plant, was negligent in failing to have a guard rail about the exciter and in permitting the wrench to be on the floor. The court lays down these general rules specially applicable to all sorts of power-plant employees:

Where a machine is so constructed as to contain no openings except those designed to permit adjustments and cleaning, and is constructed in the manner very common or universal in other plants of the same kind, and where an employee injured in contact with the machine is experienced and familiar with the surroundings, he cannot recover for such injury.

An employer is not an insurer of the safety of his employees, being merely required to use that degree of care which an ordinarily prudent person engaged in like business would use under like circumstances. Where machinery is maintained in a customary manner, the burden rests on an injured man to show that, despite the custom, the maintenance in the particular way was negligence.

An experienced power-plant employee familiar with all his surroundings assumes the risks of injury naturally inhering in the work he is required to do.

Selecting Leather Belting

By Ernest E. Elder

Whether the ruling power of the power house is designated a chief engineer or known as "Joe, down in the engine room," he has more or less to do with belts. Either he buys the belting for his company directly or he recommends to the purchasing agent or the superintendent, who does the buying, what brands or grades should be procured. In some cases he is disregarded in such matters and generally to the company's disadvantage. It may prove of advantage to the power-house man to know a few of the "whys" of the belting end of his business.

It must be borne in mind that leather grows and is not made, and so, contrary to practically everything else in the mechanical world, does not have a uniform composition. Every hide varies in thickness, in texture, in tensile strength, in percentage of stretch and in many other ways throughout its area. Also one hide differs from another, so that a leather belt made up of portions of many different hides must be carefully selected and carefully made to insure a strong and uniform product.

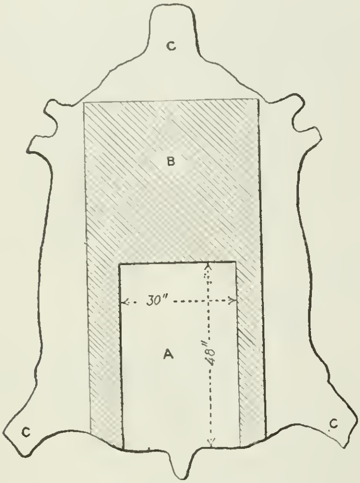


FIG. 1

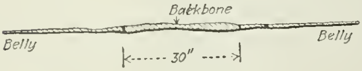


FIG. 2

FIG. 1. GREEN HIDE, SHOWING BELTING BUTT. FIG. 2. CROSS-SECTION OF HIDE

Fig. 1 shows the general shape of a green hide as taken from the animal. At the tannery the head, flanks and lower belly pieces, marked *C* in the figure, are trimmed off and used for purposes other than belting. The part *B* remaining is tanned for a belting butt. After tanning, the shoulder end of this belting butt is trimmed off to be used in cheaper-grade belting, in welting or in some other way, while the part *A* is used for first-grade belting. Right here is a vital point in the making of the belt.

How much of the belting butt is shoulder? Some manufacturers trim off all shoulders 60 in. from the tail, making the sectional pieces in the finished belt practically all 60 in. long; others trim at 54 in., others at 50 in. and a very few at 44 in. Obviously, the shorter the trim, up to a reasonable point, the better and the more expensive the belt. The main advantage in a short trim is that beyond 40 in. from the tail the average hide runs thinner and the fibers are more loosely knit. In other words, if a belt is made up of sectional pieces 48 in. or under in length, including the lap, we can be sure that this belt is as near uniform as to fibrous composition and thickness as is possible to make it.

What has been said regarding the shoulder end of the belting butt may also be applied to the belly portion, or that part parallel to and farthest from the backbone. A cross-section of a belting butt about 20 in. from the tail is shown in Fig. 2. For a distance of about 15 in. on either side of the backbone the substance is fairly uniform, but beyond that point it is less uniform and the fibers are more loosely built up.

From the foregoing it is seen that first-grade belting is made from a portion of the hide 48 in. from the tail and 15 in. on either side of the backbone, or approximately 10 sq.ft. from each hide which measures when taken from the animal about 40 sq.ft. Thus only 25% of first-grade belt leather can be obtained from each hide.

How shall we set about determining whether any particular belt has been made from this portion of the hide? By a test of tensile strength? No, for the tensile strength in a hide is greater in the shoulder and belly than along the backbone in practically all cases. Also because no two sectional pieces will show the same strength under such tests. By the amount of wrinkles, or "pipe" as it is called, which show on the grain of the belt when bent grain side in? No, for it is possible to curry a piece of leather without stretching, which will show practically no "pipe" even in the belly and shoulder portions. (The currying of leather is the stuffing with greases and oils, the setting out of the fibers and the stretching, and is a process between the tanning and manufacturing of the belt.) Also many imperfections of the grain in the belly and shoulder portions can be obliterated by buffing and straining.

Obviously then, the best way to buy high-grade leather belting is to deal with a reputable manufacturer who will gurantee that his first-grade belts are made from leather tanned and curried in the best possible manner and cut from that portion of the hide 48 in. from the tail and not over 15 in. either side of the backbone. Naturally, there are drives in every power house, as in every machine shop or factory, that are relatively unimportant, that do not operate continuously, but that must remain belted up. These should be driven by second- or third-grade belts, as it is not a paying proposition to have a first-grade belt on such a drive.

EDITORIALS

Regular Publication Resumed

ON account of labor troubles, due largely to disagreement among the unions, *Power* has not appeared regularly for several weeks. We regret this interruption of our service and communication with our subscribers and are glad to announce the completion of arrangements whereby the regular appearance of the paper has been resumed.

We could not avoid the strike, but now that service is resumed we are determined that the reader shall lose as little by its interruptions as possible. To the end that he may receive his full number of issues, we shall mail the paper at, as nearly as may be, intervals of six days, and beginning with the next issue will combine in each the reading pages of two ordinary issues. In this way we shall be able to complete the full fifty-two numbers of volume fifty by the end of the year, and to start the new volume at the commencement of 1920 on the regular date of publication and with the regular number of pages. The issue of October 14 bore the publication date of November 22, but following issues will bear their successional dates with the date of publication appended.

One of the fine things about the strike has been the splendid assurance of approval and support that it has brought from our patrons, subscribers and advertisers alike. Most of them have realized that we are contending not against an ordinary appeal for industrial betterment, but against a breach of contract so flagrant that its perpetrators were ruled out of their own union for persisting in it, and against demands so confiscatory as to suggest being a part of the syndicalists' program. In resisting these demands we have been fighting not our fight alone, but the cause of safety against unreasonable aggression of property and opportunity.

Fuel Oil Situation In The East

SOME four or five years ago fuel oil began to find a steadily growing market along the Atlantic coast, particularly in New England, remote from coal fields and where coal is high in price. Then came the war and later the taking over by the Government of the oil tankers which brought this topped crude out of Tampico. Delivery became less and less certain. The market was not dormant, however; interest in oil as boiler fuel continued keen.

In the face of this situation the owners of the Tamarack Mills in Pawtucket, Rhode Island, engaged Jenks and Ballou, engineers, of Providence, to design and build a modern steam-turbine power plant using oil as fuel. This station is noteworthy in that no provisions whatever for coal storage and handling were provided. Even the chimney was designed upon an oil-burning basis. This plant was erected after a year or more of experience with oil after changing from coal to oil in the plant of the Jenks Spinning Company, owned by the same people who own the Tamarack Mills. The performance results in both plants excited interest and were given in *Power* at the time.

About this time several plants were experiencing trouble with boiler-room labor, firemen being particularly restless. It was partly to get away from this constantly recurring trouble that one of the largest mill owners in Massachusetts changed from coal to oil. Of course there were other reasons, cost reasons, for making the change; but because oil would enable the steam demands to be met with fewer men in the boiler room with oil than with coal, the liquid fuel was adopted. Since then other plants have pursued a similar course. The Quincy Market Cold Storage and Warehouse Company, Boston, a heavy consumer of fuel, is now equipped to burn oil in its Richmond Street Station and soon will be ready for it at its large plant at Sargent's Wharf.

The coal market certainly was never more forbidding than at present. Prices have been very high for four years now, and the outlook is that they will go higher instead of remaining stationary or coming down. Perhaps the situation is reflected in the activity of what is possibly the largest coal company in New England; namely, the New England Fuel and Transportation Company, Boston. This company, through the Beacon Oil Company, recently organized, is building a refinery at tidewater at Everett, Mass., with capacity for six thousand barrels a day and six million barrels storage capacity. Unless the steel strike too long delays, this refinery will be in operation within the next six months. A little down the coast, near Fore River, the Massachusetts Oil Company is building a large refinery. Both refineries will transport Mexican crude direct from Mexican ports.

A few years ago the American Oil Engineering Company was organized in Boston. It will do consulting engineering as it relates to oil and oil burning.

The demand for fuel oil may be judged by the fact that the Mexican Petroleum Company and the Standard Oil Company have about reached the limit of their transportation facilities. Of course this situation is monetary, one may say; nevertheless it shows how great is the demand.

And the demand is not confined to New England. One finds it growing in New Jersey, New York and Eastern Pennsylvania, particularly in the Philadelphia district. New York City, which heretofore forbade its storage in buildings, is now drafting rules for its storage and use. All these places have large coal terminals.

The intelligent engineer will admit that oil makes a convenient fuel; he appreciates that changing from hand-firing coal to oil usually brings, merely because of the difference in fuels and the finer, more easily controlled combustion of oil, an increase of about six per cent in combined boiler and furnace efficiency, though it is possible to attain as high efficiency with coal as with oil; he knows it will greatly cut labor costs and troubles in a large boiler plant; the elimination of ash handling and cartage he appreciates; its, up to the present at least, low comparative price encourages him. But—there is usually a "but" to every good thing—while admitting all these advantages; he stumbles on the question of supply and delivery. How certain can he be that he will find oil available for an indefinitely long period or a comparatively short definite time? The answer is that no one knows how much oil is in the ground; that the Mexican fields, which are the fuel-oil fields because of the heavy crude, show increased production; that, recently, oil has been found in plenty, it is reported, in Colombia. More than one American company is now prospecting in South America and with success. But the real answer is that he can make a three- and possibly five-year contract, which comes near assuring him of getting his money back on the investment at least.

It is not to be imagined that oil is going to seriously affect the coal demand by power plants. Neither is it to be presumed that the oil supply is such that it will meet the rapidly growing demands for a great many years. Perhaps it will; but more evidence is needed.

Length Of Longitudinal Joints

THE contribution by C. E. Stromeyer on page ??? to the discussion on the allowable length of longitudinal joints will be read with interest—firstly, because of Mr. Stromeyer's eminence as an authority upon boiler design, and secondly, because he takes a view diametrically opposed to all of the American authorities and all of those who have heretofore discussed the question:

The Massachusetts Boiler Rules say:

> A horizontal return-tubular, vertical-tubular or locomotive-type boiler shall not have a continuous longitudinal joint over twelve feet in length.

The Boiler Code of the American Society of Mechanical Engineers says:

> In horizontal return-tubular boilers with lap joints no course shall be over twelve feet long. With butt and doublestrap construction longitudinal joints of any length may be used, provided the tension test specimens are so cut from the shell plate that their lengthwise direction is parallel with the circumferential seams of the boiler, and the tests meet the standards prescribed in the specifications for boiler plate used.

We are curious to know:

Why the Massachusetts Board considers both lap and butt-strapped joints dangerous in lengths exceeding twelve feet while the Boiler Code Committee of the A. S. M. E. is apprehensive for lap joints only.

Why the Board of Boiler Rules prohibits these joints on horizontal return-tubular, vertical, and locomotive and the A. S. M. E. only on horizontal return-tubular boilers.

If they are dangerous in the shell of a locomotive-type boiler, why they are not equally dangerous in the drums of water-tube boilers?

All the members of the Board of Boiler Rules and most of those of the A. S. M. E. Committee decline to discuss the question, although their constituencies may reasonably be curious as to why the poor old horizontal return-tubular is singled out to take the whole brunt in one case and why in both cases the inhibition is confined to boilers of three types.

Both the Massachusetts Board and the A. S. M. E. Committee and all who have discussed the matter agree that the long joint is bad and should be avoided. And now comes Mr. Stromeyer and says that he is strongly in favor of long seams, and prefers them to short ones even if the plates are rolled parallel to the seams. His statement of the stresses set up in the solid sheets opposite the ends of the joints is very interesting. One would suppose that, stressed to that extent, the sheets would show some signs of corrosion or other distress. We shall be glad to have the thoughts of other designers regarding it.

A Move To Perpetuate Power Economy

DURING the war the work of the United States Fuel Administration resulted in the gathering of a vast amount of data and information on the subject of fuel economy. From a study of some of these data, rules and suggestions for more economical processes in conjunction with fuel were issued. These rules and suggestions, which covered the production, distribution and consumption of fuels, resulted in great advantage to everyone.

With the passing of the war-time emergency this activity ceased when it was just at the beginning of its possible usefulness. The questions now come up: Are all these data to be thrown away and the work wasted? Are we to go back to pre-war wasteful methods, or will we continue to get help from the war-time work? Obviously, if any permanent results are to be obtained, the work of the Fuel Administration must be continued, at least in part. The scope of the work and the power that the body carrying it on would have to have, make it necessary that it should be done by Government agency instead of by any private interests.

With the hope of solving some of these problems the International Power Economy Conference was formed. An account of the second meeting of this conference appears in another column of this issue.

Some such action as is proposed by the conference seems especially necessary now. The present situation in the coal-mining industry makes fuel economy a very important question. And it will continue to be an important question. No matter what agreements may be made with the miners, this year, or next year, or in the more distant future, the fact remains that the most rigid fuel economy is a vital, national need. Ignorance, personal interest or personal indifference must not be allowed to continue the old-time wasteful practices. It should be the business of every American citizen to see to it that proper steps are taken to preserve the results of, and to continue the work already done toward, national fuel economy. This is "everybody's business." May the International Power Economy Conference be able to prevent it from becoming "nobody's business."

Why Not Limit Life Of Lap Seam Boiler?

Again the lap seam boiler. This time an explosion resulting in no fatalities but in property damage approximating $10,000, as explained on other pages of this issue. The lap seam design has been a prolific source of accident, usually severe and frequently fatal, and the treacherous part of it is that the initial flaw or weakness is usually invisible to external inspection. The weakness of the design has been realized for years and in the standard boiler code of the day, precautions have been taken to prevent the sale or use of new boilers of this type. Unfortunately the code has not been adopted universally and even where it is in effect, such designs are allowed to continue in operation. Eventually there will be no lap seam boilers, but why not hasten the day. Limiting their useful life to a comparatively short period, say ten years, would sooner rid the country of a design known to be faulty and by eradicating one of the chief causes of accident, reduce the number of boiler explosions and the resulting fatalities and damage.

CORRESPONDENCE

Blowing Down Boilers

Referring to the editorial on page 472 of the Sept. 16 issue of *Power*, the question comes, Why blow down "one gage" on a boiler every shift? Why not "one-half gage"?

From my own experience I think that less water blown at a time, but more often, would be better. When opening the valve I have noticed that you can feel or hear the fine scale leaving the boiler. This could be noticed only about as long as it took to open the valve wide. This led me to try some experiments on three return-tubular boilers.

First, I had one gage blown out twice every twenty-four hours for two weeks. Then after cleaning, one of the boilers was blown just long enough to open and close the valve, which in this case was a quarter-turn valve. When this boiler was taken off for cleaning, no difference could be seen. Of course if very poor water is used without a water softener, more blowing would be required.

I have been on the road with large locomotives when the blowoff valves would not be opened for 36 hours, and had no trouble from priming. Why should stationary boilers be blown so often when it is not done in locomotive practice? L. A. Cole.

Columbus, Ohio.

It seems likely that the noise heard, on opening the valve, was due to the rush of water through the partly opened valve. This does not lessen the importance of Mr. Cole's suggestions.—Editor.

Better Cylinder Oil-Testing Methods

Wilbert Walton Cranford, on page 314 of the Aug. 19 issue, asks how I test cylinder oils. In reply I would ask that Mr. Cranford read my letter on "Testing Cylinder Oils," page 256 of the Feb. 18 issue.

In the final windup every engineer must test his cylinder oils on an engine; however, it is not essential that the oil be tested on the engine in which it is used, provided the steam conditions (moisture, super-heat and priming) are approximately the same.

In practice it is neither necessary nor advisable to test out cylinder oils frequently with a view of making a change in the brand. There are many reputable oil concerns that take pride in supplying suitable oils to the customers in their district. The difficulty is that too many concerns want the cheapest thing they can find regardless of quality. In some cases an old fogy mill superintendent, who has always used a cheap cylinder oil, will not consider the purchase of an oil that may cost more than twice what he has been paying. He prefers a stock compounded with 2 or 3 per cent. animal oil made from fertilizer carcasses and full of oleatic acid.

There are several well-known brands of cylinder oils that smell good enough to eat, and they are good oils for any cylinder. I have found the smelling test to be very reliable, as straight mineral oils can be spotted at once. Pennsylvania cylinder stocks can also be assured, as Western asphalt stocks smell considerably different, having a strong tarry odor. The refining process also has considerable to do with the odor. The smelling test can be learned easily by selecting well-known oils. Smell the oil when hot in a can or pot; then heat some of the cheaper oils and notice the contrast.

I have operated 22 engines of the same make, which I have found to be the most difficult engine built to lubricate, because the valves must be copiously lubricated to insure proper governor action, and in all cases I have found the highest-grade cylinder oils cheaper and far more satisfactory than the low-grade oils—to say nothing about the reduced repair bills.

If it is Pennsylvania or Eastern crude, compounded 5 to 10 per cent. acidless tallow oil, the engineer need not worry. The fire test need not exceed 600 deg. even with steam at 200 lb. pressure; the viscosity has practically nothing to do with the quality. The heavy, draggy oils are an indication of Western stock and poor refining and filtering. Red filtered stocks are preferable to dark stocks, as the latter have a tendency to produce "sweat corrosion" in the cylinder while shut down. Oil refiners do not push the sale of red filtered stocks because it is necessary to compound them of heavier oils, they claim, and because the ratio of profit is much less than on dark, draggy cylinder oils; hence they naturally prefer to sell the latter.

Some years ago I tested out to various brands of cylinder oil a box-valve engine running at 133 r.p.m. The cheapest oil cost $1.12 per day, averaged for a month, while the high-grade oils averaged from 78 to 50 cents per day averaged for the same length of time. I could give like data on other similar engines ranging from 75 to 600 hp., high, medium and low-speed, in which the quantity of oil was reduced, in most cases, to about one-half when the high-grade cylinder oils were applied. The service was also much better, and the cylinder barrels invariably shone like a looking-glass.

Franklin, Ohio. Waldo Weaver.

What Should Be the Maximum Length of a Longitudinal Joint?

In compliance with your request I have much pleasure in sending you a few remarks on longitudinal joints, but in doing so it will be impossible for me to avoid drawing attention to differences of engineering views on either side of the Atlantic. In England human life is idolized almost to the same extent as animal life is idolized in India, and having made boilers almost absolutely safe, fatal boiler explosions rarely reaching a dozen per annum, we feel startled when we read of the number of American boiler explosions. I was shocked, when on a recent occasion I read an address by an American engineer who claimed to be qualified to speak about the practical working of boilers because he had been present at a dozen boiler explosions and had had as many hairbreadth escapes. Such an exciting experience is quite impossible in England, and I cannot help thinking that there must be other causes than the use of long longitudinal seams to account for these numerous explosions. Remove these other causes and the question of length of joints will sink into insignificance. However, the true effect of long joints should be carefully inquired into.

The present inquiry is somewhat analagous to one which Sir H. Maxim addressed to me about 25 years ago, while he was building his flying machine. I had just published my work on "Marine Boilers," and Maxim invited me to meet Professor Langley and discuss the question of lowest factor of safety for the boiler which he was going to place on board his machine. I remember telling him that if he was going to risk his life in the flying machine which was then nearly completed, he might as well run the risk of being blown up by a boiler explosion, and, seeing that the customary factor of safety of five was absolutely safe, no boiler with this factor having ever exploded, he might reasonably adopt a factor of safety of two and a half, for that was the factor of safety during hydraulic tests, which very rarely resulted in failure. But, I added, the calculation of the stresses in his boiler would have to be more precise than was then customary.

Similarly, if American engineers do not mind risking their lives a dozen times, let them continue the present practices; but whenever they propose new departures, they should study them with as much care as Maxim would have had to study the stresses in his proposed boiler.

Some of the spade work of the necessary investigation has fortunately been carried out by me and published in the "Transactions of the Institute of Naval Architects," 1886, Vol. 27, p. 34. I had been using several strain indicators on ships and boilers. One of these instruments made use of the interference bands of monochromatic light and enabled me to measure strains on short spans of fractions of an inch. Roughly speaking, this instrument was able to measure changes of length with an accuracy of one two hundred-thousandth of an inch, and on a span of one inch this minute deformation represents a stress of only 150 lb. per square inch.

With this instrument I measured the strains in the solid plate of boilers on either end of lap joints, and also in the solid plates above and below the then customary single-butt-strap joint of the hulls of iron ships. My observations showed that the strains in the solid plates close to the ends of lap joints were eight times greater than those in the solid plates away from the joints. Assuming that these joints had only 70 per cent. of the strength of the solid plate, it is evident that the plates that adjoin lap joints are stressed about five times more severely than the joints themselves. Of course these observations do not extend beyond the elastic limit of the material. They were confirmed, or rather they had been confirmed, by unpublished experiments made in 1874 by the Manchester Steam Users' Association on a full-sized boiler whose solid plates ruptured under hydraulic pressure when the seams gave way.

The conclusion that is to be drawn from these two sets of experiments is that the breaking of joints is a source of weakness and the longer we make the longitudinal joints of boilers the better. This principle could not at the time be carried out in boilers because of the impossibility in those days of rolling sufficiently wide plates, but subsequently many marine boilers have been built with single strakes.

Only two marine boilers built on this principle have failed; but having examined the fractures and analyzed the metal, I have no hesitation in attributing these failures to the steel, which was basic and contained a high percentage of nitrogen.

My experiments on the strain in ships' (hull) plates showed that the strains in the solid plates above and below single-butt joints were twelve times greater than the estimated stresses in the seams. My remarks seem to have had a far-reaching effect, for it may safely be said that before my paper was read every iron ship was built with single-butt joints, but now lap joints are almost universal in ships' hulls, although, as well known, lap joints offer more resistance to the movement of a ship than a perfectly smooth skin.

There is perhaps no need for me to repeat that I am strongly in favor of long seams, and I would prefer these to short ones even if the plates were rolled parallel to the seams; but I have to qualify this remark by saying that it is intended to apply only to steels made by the acid openhearth process. Of this steel it may be safely said that it is absolutely reliable, not a single failure having occurred in any boiler built of this material with a factor of safety of from five to four. What would happen with basic steel is impossible for me to say, for published experiences of failures have been so very discouraging that the Manchester Steam Users' Association has, up to now, refused to sanction its use in boilers and we have therefore no direct experience with this material.

Coming back to my opening remarks, we have been very successful in preventing loss of life. Since our foundation in 1854 up to the present day we have had no preventable explosion although we have issued over half a million certificates of safety; and up to the war we have had no loss of life. The very few failures that have occurred with our boilers have been due either to inoperative safety valves to shortness of water or to scale. These are matters over which we had no control. None of our few failures was due to faulty material or to structural weakness. Under these circumstances we are justified in looking on boilers as being very safe structures, and we would not object to long longitudinal joints. I doubt however whether the same conclusion would be drawn if we had frequent explosions among our boilers, and I hope therefore that my remarks, which are based on English experience, will not be applied to American boiler practice, which evidently differs in a very marked degree from ours.

C. E. STROMEYER,
Chief Engineer Manchester Steam Users' Association for the Prevention of Boiler Explosions.

Changed Switchboard Connections To Improve Operation

In assuming charge of a power plant several years ago, I found some conditions in connection with the switchboard which seemed radically wrong for efficient operation. In the first place the connection from the plug switches, for connecting the voltmeter with each of the generators for use in paralleling the machine, was connected across the generator leads between the circuit-breaker and the main switch, as in Fig. 1, instead of directly across the armature leads, as in Fig. 2. Consequently no reading would be shown on the voltmeter after the machine was started until the circuit-breaker was closed. The engineer therefore left the circuit-breaker in at all times, pulling the switches on any machine they were cutting off the busbars. This condition was easily corrected by shifting each pair of voltmeter wires directly across the leads coming from the armature of each generator, as in Fig. 2. The practice of putting in the circuit-breaker before the voltage builds up may lead a new or absent-minded engineer to close the main switch with disastrous results. I think it preferable for an engineer to start the engine and build up the voltage before touching anything on the switchboard, other than the field rheostat and voltmeter switch; then he's playing safe.

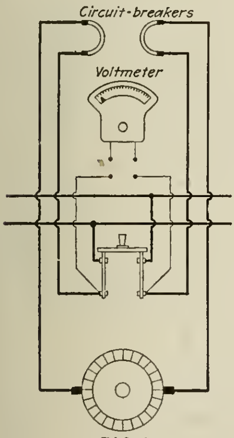


FIG. 1

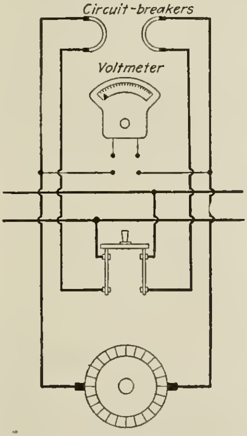


FIG. 2

FIGS. 1 AND 2. VOLTMETER CONNECTED TO GENERATOR SWITCH AND DIRECT TO GENERATOR

Another thing, the illumination for the switchboard meters was provided by individual 120-volt lamps behind each dial. Each lamp was supplied with current by a pair of wires running across the back of the switchboard. This was all right for the voltmeters, but with the ammeters it meant either burning the light on the meters on machines not in service, or getting a ladder each time the generators were changed over and shifting the lights or leaving the lights out. As might well be imagined, the lights were always out. This was changed as follows:

The line voltage being 240, the lamps behind the two ammeters on each machine were connected in series across the armature leads of the respective generators, as in Fig. 3. Thus, when a machine started the lights gradually lighted up as the voltage increased to normal value. While improving the appearance of the switchboard, however, they performed a far more important service. If, owing to trouble on the line, the circuit-breakers on the generators opened, the lights from the ammeter dials were sufficient to enable the operator to handle the switchboard.

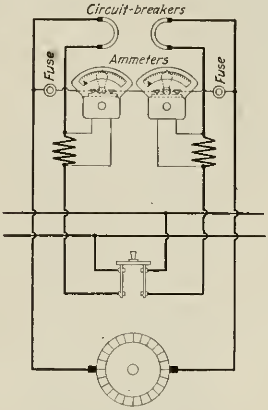


FIG. 3

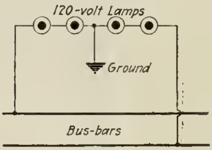


FIG. 4

FIGS. 3 AND 4. SHOWING AMMETER-LAMP AND GROUND-LAMP CONNECTIONS

Another addition to the board which soon proved its worth was ground lamps. Four 120-volt lamps were connected in series across the 220-volt bus with a ground wire connected so as to put two lamps in series with the ground on each side of the circuit. The four lamps being connected in series across the two busbars burned on half voltage. A ground on the system would cause one pair of lamps to go out, while the other would light up to full brilliancy, the ground being on the side of the circuit to which the dark lamps were connected.

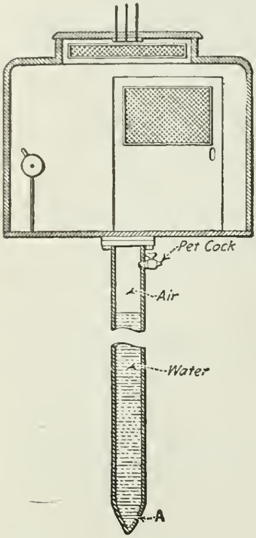
I might add that the voltmeter was arranged so that by means of a switch the intensity of the ground on either side of the system could be measured. While the voltmeter method of testing for ground is very desirable, especially in locating slight grounds in motors, lamps, canopies, sockets, etc., bad grounds, which it is so desirable to discover before they do serious damage, are instantaneously called to the attention of the switchboard operator by the action of the ground lamp. For the best results both systems of detecting grounds are necessary on a switchboard.

New York City. WARREN D. LEWIS.

Hole in Plunger Caused Elevator Trouble

A private residence was equipped with a hydraulic elevator. When the lady of the house, who weighed over 200 lb., entered the car, the elevator would sink about 6 in., and when she got off it jumped up an equal distance. This got on her nerves and she sent a hurry call to the city for an elevator man.

This man and his helper spent all day putting in new cup packings and packing plunger glands, but the elevator acted just as badly as before. The foreman of the shop was sent for, but he could not locate the trouble. Finally, it was discovered that air was the cause, owing to the fact that a hole had developed at the bottom of the plunger, as shown at *A*, due to corrosion. As a result, the plunger partly filled with water and the air in the upper part acted as a cushion. A ¼-in. hole was drilled and tapped for a pet-cock, as shown. This did the trick until a new bottom section was secured and put in place.



PARTLY FILLED PLUNGER

Springfield, Mass. THOMAS SHEEHAN.

Owners Should Supply Instruments

I see, in the July 15 issue of *Power*, page 116, that J. B. Tait is of the opinion that owners of power plants should supply all instruments used which tend to improve the economy of the plant. Candidly, I am of the same opinion, for in many cases the engineer receives but little thanks for improved economy and there is no immediate return for the money expanded for such instruments.

At one time I was operating an automatic engine running 115 r.p.m. This engine required all the steam that three 150-hp. gas-fired boilers could make. After being there for three weeks I put on the indicator and obtained a few diagrams, and the following Sunday I opened the steam chest to see what was wrong and found that there was about $\frac{1}{16}$ in. between the face of the valve and the pressure plate. After adjusting things we found that two boilers would carry the load and a saving of $7 per day was made in the gas bill, but not a cent raise in salary.

At another time we had a throttling slide-valve engine, directly coupled to an ice machine, the speed being 75 r.p.m. The compression was low and the cutoff was a little past ¾ stroke, so a ⅜-in. strip was added to the steam lap, which brought the cutoff to a little less than half-stroke. After this change, we could see a difference in the coal fired to the boiler.

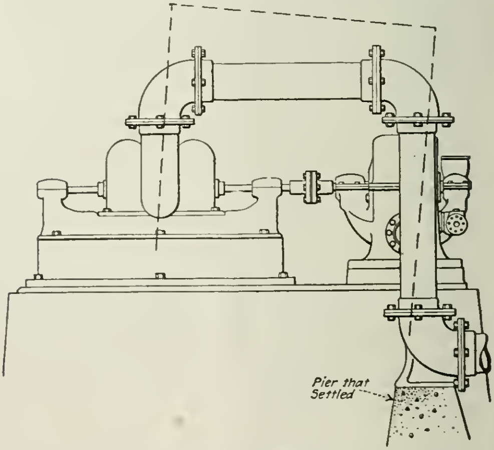
At one time I bought a hand CO_2 instrument costing $340. As I wished to learn its use, and after reading the instructions thoroughly, I tried it out on a 150-hp. return-tubular boiler and found an average CO_2 of 6 per cent. I asked the firemen to change his method of firing, and he began to take some interest in the proceeding. We obtained 12 to 14 per cent. CO_2 and a stack temperature of 475 to 500 deg. F., but the owner or manager took no interest at all and I came to the conclusion I would sell the instrument, which I did. Then and there I said never would I buy another instrument to increase economy and benefit the other fellow. I concluded that if they have not enough interest in the economy of their own plant to furnish any and all instruments, I would do my best with what I had. However, I will always keep an indicator.

Columbus, Ohio. A. L. COWLES.

Shaft Alignment

W. A. London's letter, under the caption "Shaft Alignment" on page 351 of the Aug. 26 issue, is worthy of notice. It has been my experience to have more or less pumping machinery operated through the flexible coupling.

Not long ago one of my associates asked the questions: "Why introduce a flexible coupling between the steam turbine and centrifugal pump? Why not eliminate one bearing, as we do in the motor-exciter set?" Shortly after he was shown in rather a forcible way the value of couplings. A pier settled under the discharge pipe of the pump (see illustration), and the distortion was sufficient to cause the rubber bumper in the coupling to go to pieces, but the bearing was not injured.

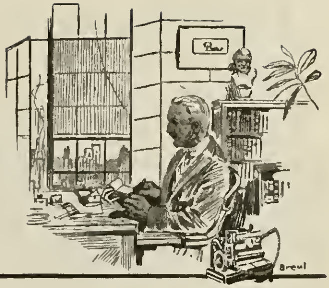


DOTTED LINE SHOWS TENDENCY OF PIPE POSITION WHEN PIER SETTLED

The baseplate of the ordinary unit of this kind is more or less easily warped, and it seems to me that all installations of this type should be equipped with flexible piping joints as well as flexible shaft couplings. For one I would never ask for three bearings; four bearings with the flexible unit between the two center bearings is a good mechanical combination. Many pump builders equip their apparatus with the prime mover specified by the purchaser, and it would be rather a delicate proposition to leave out a bearing.

New York City. C. W. PETERS.

INQUIRIES OF GENERAL INTEREST



Reason for Lap of Corliss Steam Valves—Why is lap given to the steam valves of a single-eccentric Corliss engine?
H. L.

To obtain early release after expansion and compression of the exhaust, it is necessary to advance the eccentric ahead of the 90-deg. position. With the eccentric advanced, all the valve events occur earlier in the stroke and, when the wristplate is in its central position, the steam valves must have sufficient lap to be closed long enough to prevent excessive lead.

Carbon Mineral or Mined Coal—We have an inquiry from a Central American customer for a boiler that is to be provided with grate suitable for burning "mineral coal." What particular kind of fuel is referred to?
S. H.

In Spanish-American countries, extensive use is made of charcoal (carbon de leña) and your correspondent intends to confine consideration to mined coal, for which the Spanish technical designation is "carbon mineral" and the common designation is "carbón de piedra," or stone coal. The inquiry undoubtedly refers to use of a low grade of bituminous coal.

Rating of Alternating-Current Generators—What is the kilowatt rating of a 550-volt 300-amperes three-phase alternator at 0.80 power factor? What would be the machine's kilowatt rating at unity power factor?
H. A. L.

At unity power factor the alternator would have a kilowatt rating equal to volts × amperes × 1.732 × power factor ÷ 1000 $= 550 \times 300 \times 1.732 \times 1 \div 1000 = 285.78$. This means that this machine when operated at unity power factor can supply a load of 286.78 kw. At 0.80 power factor the kilowatt rating $= 550 \times 300 \times 1.732 \times 0.80 \div 1000 = 228.62$; that is, at 80 per cent. power factor the alternator can supply only a 228.62 kilowatts load.

Hp. Constant and Required M. E. P.—What is the horsepower constant of an 18-in. × 48-in. engine running 74 r.p.m., and what would be mean effective pressure for development of 375 indicated horsepower?
R. W. R.

The horsepower constant, or power developed per pound of mean effective pressure, is found by the usual formula,

$$Hp. = \frac{PLAN}{33{,}000}$$

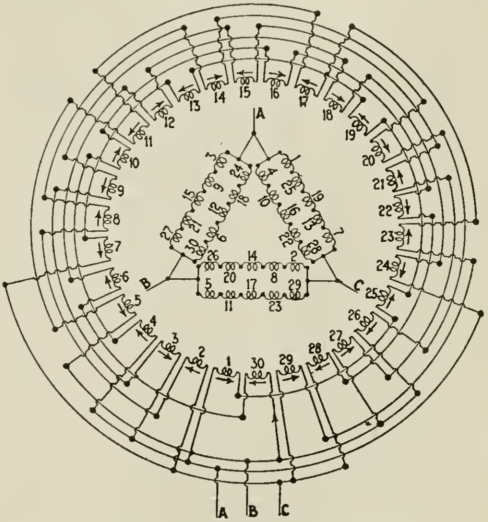
assuming $P = 1$; $L =$ length of stroke in feet; $A =$ area of piston; and $N =$ the number of single of strokes. Hence, for the conditions

$$Hp.\ constant = \frac{1 \times \frac{48}{12} \times (18 \times 18 \times 0.7854) \times 74 \times 2}{33000} = 4.565.$$

Development of 375 i. hp. would require $375 \div 4.565 = 82.15$ lb. m. e. p.

Reconnecting Synchronous Motor—We have a 6600-volt, three-phase, 60-cycle 720-r.p.m. synchronous motor connected one circuit "Y." The machine has 60 slots in the stator; two slots per pole per phase. We would like to reconnect this motor so as to operate on a 2200-volt circuit at 720 r.p.m. How should the windings be connected?
W. H. K.

The machine as it is now connected has 10 poles; 2200 volts, is one-third of 6600, therefore the winding should be reconnected, for 2200 volts, so as to give one-third the number of turns in series in the 6600-volt winding, or 3-parallel star. However, the connection cannot be obtained since the machine has 10 poles, and 10 is not divisible by 3. The only other connection that can be made which offers a possibility of satisfactory operation is a 2-parallel delta, as in the figure; but this is good for only $\frac{6600}{2 \times 1.732} = 1905$ volts. With the winding connected 2-parallel delta and operating 2200 volts, it will be working at $\frac{2200 \times 100}{1905} - 100 = 15$ per cent. overvoltage. This overvoltage would in general be excessive, therefore it is advisable to take up with the manufacturer the question as to the advisability of subjecting the motor to this overvoltage. The full pitch of the winding would be 6 slots; that is, the coils would be wound in slots 1 and 7. If the coils happened to be wound in slots 1 and 6, the cord factor would be 0.95. Increasing the pitch of the winding to 1 to 7, or full pitch, would make it suitable for operation on $\frac{1905}{0.95} = 2005$ volts, or the motor would then be operating at 10.7 per cent. overvoltage. If this condition can be met, there is little doubt that the motor will operate on 2200 volts.



TEN-POLE TWO-PARALLEL DELTA CONNECTION

Excerpts From Elevator Regulations, State of Massachusetts

By EDWARD A. SMITH

Mechanical Engineer, Otis Elevator Co., New York, N. Y.

EXCERPTS from the elevator laws of the State of Massachusetts for power-driven passenger, freight and sidewalk elevators. Effective June 19, 1914, revised June 19, 1915. For all elevators in the state except Boston and United States Government installations. The excerpts are from the laws pertaining to both existing and future installations. Where the law is for future installations only, it is not quoted except where noted.

Current: Passenger, Freight and Sidewalk—Existing and future, 250 volts maximum allowed at car switch on push-button.

Safeties and Governors: Passenger—Future installations require gradual-stop type of safeties with governor for speeds over 100 ft. per min. Speed 100 ft. per min. or less, either gradual with governor or instantaneous, rail-type, with governor, or broken-rope spring-grip type. For vertical-hydraulic machines rising over 15 ft., either gradual or instantaneous with governor 100 ft. per min. or less; rise 15 ft. or less, no safety required. Existing counterweight to have safeties if counterweight does not run down to bottom and space below is used. Safeties on all passenger elevators to be below car bottom. Existing installations same as above except instantaneous, with governor permitted for all speeds and safety may be in crosshead. Freight—Same as passenger, existing and future, belt- or chain-driven elevators, 100 ft. per min. or less, rise over 40 ft. permitted. Must have safeties either gradual or instantaneous with governor; under 40 ft. rise broken-rope type of safety permitted. Carriage-type and hatchway-type require no safeties.

CAR ENCLOSURES AND PLATFORMS

Car Enclosure, Platform and Slings: Passenger—Existing and future installations, wood or metal solid or open 2-in. mesh. Future only, all unused sides and top. If open mesh is over ⅜-in., use ⅜-in. mesh, No. 20 wire screen over counterweight, if clearance is less than 6 in. and sides if clearance is less than 4 in. Not more than two openings permitted; ¾ in. clearance between car and sill, 1½ in. maximum; 1 in. minimum between car and counterweight; ¾ in. minimum between car and shaft. Gates with contacts required if car has two openings. No contacts on existing elevator if operator can protect opening. If car has no licensed operator, gates to be furnished on cars with contacts or interlocks and contacts on shaft doors of electric elevators. Car domes to be cut back or hinged with brass, bronze or composition hinges, 15 in. back from sill, if either no gate is furnished or no interlock on shaft doors. Above can act as emergency exit. Not more than one compartment permitted, except in existing elevators, and must have car gates or doors with contacts or interlocks on shaft doors. Freight—If mesh of car enclosure is larger than ⅜ in., use ⅜-in. mesh No. 20 wire screen over counterweight; if clearance is less than 4 in., inclosure must be 6 ft. 6 in. high on all unused sides or to crosshead if lower. Warning chains 30 in. long, 6 in. centers, required. No enclosure required on carriage-type elevator. Tops required, except for hatchway-type and carriage-type or where semiautomatic gates extend to floors, all floors above lowest or where doors are furnished at all floors locked from shaft side and kept closed. Top to be of 1½-in. x 3-in. mesh No. 9 gage wire or equivalent strength, cut back not over 6 in. from sill at landings and hinged not less than 18 in. No emergency exit required. If existing or future freight cars carry more than two persons and operator, they must be enclosed on all sides, except a 42-in. or less door opening or equipped with car gates or doors. Portable enclosure or gates permitted if freight car is used stated hours for passenger service. No auxiliary department permitted except for existing elevator (see passenger). Openings in car enclosure permitted for hand-rope. Car or shaft to be lighted except hatchway-type and carriage-type to have light at each floor near elevator or in shaft if solid enclosure. Sidewalk—Must have light at each floor near elevator or in hatchway if solid enclosure.

Control: Passenger, Freight and Sidewalk—Switch (push-button allowed in private houses, apartment houses and private offices), wheel or lever, 150 ft. per min. maximum (future only) except hydraulic elevator. Direct-connected traction exceeding 200 ft. per min., switch required, to have two speeds. Hand-rope 150 ft. per min. maximum, centering ropes to be provided except sidewalk.

Hatchway Gates: Passenger—Not permitted. Freight—Gates may be full-automatic gravity-drop, semiautomatic or gravity, of metal or hardwood strength of ash, joints to have metal plates. Gate shoes and runs on operating sides to be of metal. Bar gates hinged at one end to have accurate and rigid support when closed. Gates not required where shaft doors are arranged to be opened from shaft side except by key from outside and a licensed operator on car. Collapsing gates where there is danger from shear not permitted. Semiautomatic Peelle-type gates or doors not permitted unless arranged to open from shaft side only and regular operator on car. Double-blade gates permitted if solid or ⅜-in. mesh and no danger from shear. Existing gate 4 ft. high or higher if practicable. Top-story gate need be only 3 ft. 4 in. high. Gates to have locks that cannot be opened from outside and are opened by car. Above does not apply if landing is on a bridge, above ground and not public. Above also applies to ground openings, elevators located outside building. Sidewalk—Gates not required at bottom landing where elevator serves only two adjacent floors, but must have hand operated bar, gate or chain.

ROPES FOR PASSENGER ELEVATORS

Ropes: Passenger—Iron or steel (marlin-covered prohibited for passenger service). Each steel cable tagged "Steel Cable" on metal plate 1 in. minimum diameter, above shackle. Two hoisting cables each to car and counterweight. One counterweight cable permitted to remain on existing installations. One full turn on drum for car and counterweight when at limit of travel. Drum ends secured by clamps or tapered sockets. Governor ropes to be steel for speeds over 100 ft. per min., hemp 100 ft. per min. or under. Shipper ropes to be inaccessible from landing openings in outside walls. Shipper ropes to be insulated if necessary. Freight—Same as passenger. One rope permitted on counterweight if 1400 lb. or less. One lift and one counterweight cable permitted to remain on existing installations and not carrying more than three persons. Sidewalk—Same as freight. Chains permitted.

Grating: Passenger—Platform under machine and sheaves to sustain lead of 50 lb. per sq. ft.; wood, solid 3-in. plank, existing plank may remain if it sustains 50 lb. per sq. ft. Grating 1½-in. centers covered with ⅜-in. square No. 20 gage wire netting. If hatch has over 50 sq. ft. area, platform 2 ft. beyond machine and sheaves, with baseboard 6 in. high is required. If space between platform and wall exceeds 12 in., hand-rail 2 ft. 6 in. above platform required. Access permitted from top of car. Existing hatch ladder from top floor to opening in grating permitted for emergency. Freight—Same as passenger except not required on existing and future hatchway-type or carriage-type elevators.

Counterweight Screens: Passenger—No top screen required. Bottom screen solid metal or screen ½-in. mesh 6 ft. 6 in. high, bottom or screen 6 in. above pit, except where compensating chains would interfere, or except where counterweight bumpers are 5 ft. or more high. Counterweights in isolated shaftways inclose full height with fire-resisting construction or No. 16 gage steel, with removable section 2 ft. from top, except outside building enclosure only 7 ft. high required. Open existing enclosure may be covered with ⅜-in. mesh No. 20 gage. Freight—Same as passenger, except existing and future hatchway-type elevator counterweights, which shall be boxed in from bottom of pit full height to as close to sheave as possible and top covered except for ropes, with removable section 2 ft. from top or to clear hatchway door when open.

Stop Motions and Shaft Limits: Passenger and Freight—Power-driven elevators (except traction and plunger type) rise 30 ft. or less, speed 150 ft. per min. or less) to have machine limits set to stop car or counterweight before 18 in. above normal travel, or one-half of run-by when less than 3 ft. Chocker-valves on hydraulic machines are considered as machine limits and on existing operating valves automatically closed by machine independent of shipper rope. No chain- or rope-driven stop motion except in addition to regular machine stop motion permitted on drum machines. Switch or push-button controlled elevators to have shaft limits, operated by car and counterweight and to stop machine before 18 in. above normal travel, or one-half of run-by if less than 3 ft. Two- or three-phase electric machines to have shaft limits in addition to machine limits. Hand-rope control to have stop balls to stop cars not to exceed 6 in. above top and below bottom floors. Sidewalk—Machine limits if drum machine and stop balls on rope of all machines.

Interlocks Required on Swing Doors

Interlocks: Passenger—Swing doors must have interlocks or contacts; push-button or dual (push-button and switch) control to have standard push-button interlocks. Shipper ropes that are accessible from landings doors to have interlocks or contacts. All doors in outside walls to have interlocks. Existing elevators with compartments must have contacts on car gates or doors or interlocks on shaft doors. Car gates away from operator to have contacts. Elevators without licensed operator to have contact on car gate or door. Freight—Push-button or dual control (push-button and switch) to have standard push-button interlocks. Gates and doors in outside walls to have interlocks. Existing elevators with compartments must have contacts on car gates or doors or interlocks on shaft doors. Sidewalk—No interlocks required serving two floors only; if more than two floors, same as freight.

Emergency Switches: Passenger—Emergency switch or stop-button in all switch or push-button control elevators to control main-line circuit in cable independent of car control. Slack-cable device required on all drum machines over 15 ft. rise. Elevators to have annunciator or other signal system operating from each landing except in private residences or cars with no licensed operator. Freight—Same as passenger except no slack-cable device required on carriage type or on existing freight machines located above top landing and carrying not over three persons. Centering ropes required on hand-rope operations. If signal system is not furnished, a bell must be furnished in shaft which can be heard from and operated from all floors. Not required for two stories only. Gong required with sliding hatch covers; not required with hinged covers.

Rope Locks: Passenger—Not required, but permitted. Freight—Rope lock required.

Hatchway Enclosures: Passenger—Future installations, enclosed full height with brick, terra cotta, wire lath and plaster, wired glass set in metal frames or other fire-resisting construction. Thickness of wall, wire glass to conform to local city regulations if any. Sash stationary except in outer wall and frames, and sash may be of wood, plate glass if local laws permit. Exterior windows to have ⅝-in. vertical metal bars on outside 10-in. center and painted. Fireproof enclosure not required within wellways of surrounding stairs. Fireproof enclosure not required for elevators outside of building. Solid or 2-in. grille 7 ft. high above grade. Fire proof enclosure not required for hatchway type. Enclosure 3 ft. 4 in. high except on landing sides with grille sheathing, wood or metal double-rail fence except where there is 2 ft. or more clearance above vertical lift covers for top floor. If future hatchway pierces one floor only, one story to be of fireproof material and full height, other floor metal, grille or equivalent 2-in. mesh 7 ft. high, and if on lower floor full height at openings, except outside building or in stair-wells. Where grille is used larger than ⅜-in. sq. mesh to be covered 6 ft. 6 in. high ⅜-in. sq. mesh No. 20 gage wire only, where there is less than 4 in. between grille and sliding door. Sills projecting 1 in. or more to be beveled on underside 60 deg. with horizontal.

Existing Installations: Enclosures for hatchway type same as future; enclosures for outside building same as future; all other enclosures at each floor except at landing to be 7 ft. high solid or 2-in. grille, to be covered same as future if mesh is larger than ⅜-in. square. Freight—Same as passenger except future elevators and piercing one floor only if top floor is fireproof; bottom floor may be grille, sheathing, wood or metal double-rail fence 3 ft. 4 in. high. Carriage type piercing one floor only, enclosure 3 ft. 4 in. high grille, sheathing, wood or metal double-rail fence. Carriage type rising more than two floors, fireproof full height above second floor. Existing and future, windows and recesses to be made flush with vertical bars or slats 3 in. x ⅞ in., or pipes not over 4 in. apart. Not to be furnished if semi-automatic gates or gates with contacts are furnished on car, or car is enclosed on window side. If above bars are furnished, ⅝-in. iron bars 10 in. centers on outside all exterior windows required. Sidewalk—No enclosure required except at sidewalk level; public passageway to be protected by wood or pipe guard 18 in. high before elevator is started. If manually operated doors, the doors with rod to act as guard.

Enclosure Not Required in Engine Room

Motor-room Enclosure: Passenger and Freight—Located on floor, to be enclosed solid or 2-in. grille 4 ft. high. If located in engine or pump room, no enclosure required. Free and safe access to be provided to all parts of machine. Penthouse door to be furnished.

Licensed Operator: Licensed operator required for passenger, except push-button type, or where shipper rope accessible from landing; or elevator serving two landings and doors equipped with push-button interlocks; or elevator in private house (one family). Freight—Licensed operator required where car runs over 100 ft. per min. or carrying four persons including operator, or where no landing gates are provided except for elevators serving two landings. License application made on blanks, person over 18 years old, on recommendation to local authorities by owner, occupant or lessee or by two persons, term one year. Fee $1; renewal, 50c. Operator to carry license on person. In emergency a competent unlicensed person permitted for seven consecutive days. If elevator not requiring licensed operator is not being operated with regard to safety, inspector will appoint designated operator or operators. Designated operators for permanent elevators in unfinished buildings.

Belt or Main Drive Prohibited

Hydraulic Tanks, Valves, Cylinders: Pressure tanks to have dials or gages graduated to not less than 1½ times maximum pressure, and connected to tank with brass pipe and with cock with T or lever handle near gage. Also water-glass gage connection with brass pipe. No cast-iron or flat-stayed heads allowed. Tanks to be provided with ¼-in. pipe to attach inspector's gage. Tanks to be supported so they can be inspected all sides and ends. Pump to have water-relief valve. Relief valves to be set to discharge at safe working pressure of tank and cannot be shut off. Relief valves may be piped to discharge tank or pump suction. Steam pumps to have pressure regulators. Electric pumps to have automatic pressure regulators to control motor or automatic bypasses. Vertical hydraulic sheave straps to be two-part steel or iron hangers, no U-straps allowed.

Installations Prohibited: Belt or chaindriven machines not permitted for passenger service. Means must be provided for throwing the power off a belt or chaindriven machine, if machine is not driven by separate motor. Elevator belts within 7 ft. from floor to be properly guarded. Friction gearing or clutch mechanism prohibited on any machine where a person is carried.

Repairs and Alterations: An existing installation moved to a new location will be considered a new installation, also an existing installation that is materially changed. Any changes other than ordinary repairs are material changes. New parts furnished must comply to rules for new installations, but machine or ropes can be changed without changing car, shaft enclosure, gates, doors, etc. If platform is attached to existing hoisting mechanism not previously equipped with platform, it will become a new installation.

International Power Economy Conference

On Oct. 30 and 31 the International Power Economy Conference, an association of manufacturers of power-plant products, held its second meeting in the rooms of the Western Society of Engineers, Chicago. Nearly a year ago the movement had been instigated by C. A. Tupper to promote power-plant efficiency and fuel conservation by perpetuating the work started by the Fuel Administration during the war. An executive committee had been appointed and eventually nineteen other committees representative of the various phases of power-plant economy. There were committees on combustion, fuels, engines, turbines, boiler settings, insulation, instruments, lubrication, coal and ash handling, etc. These committees were to analyze the relation of the various apparatus and appliances to the general subject and report in a tentative way as to the part each might play in coördinating the efforts to bring about a greater appreciation, of the advantages resulting from intelligent use of the apparatus or product in question.

At the meeting the chairmen of most of these committees presented brief reports, but the primary object of the present gathering was to decide more definitely what was to be done and how to do it. The following report of a committee appointed for the purpose will give explicitly the objects and the method of procedure:

Disinterested public service in the subject of conservation of fuel resources.

We are initiating this movement because of our direct understanding of conditions and desire to convert to the public good our specialized knowledge of this subject.

We, having had direct and intimate acquaintance with the work and results of the Fuel Administration during the war, believe that the results accomplished were substantial and in the interest of the public at large, and we, the International Power Economy Conference, advocate the continuance of the work of the Administration through the Bureau of Mines, or suitable Government agency.

We are convinced that the losses are so widespread and ingrained that only Governmental action will result in securing effective improvement.

Serious waste occurs in mining, preparation, transportation and utilization of fuel, much of which is preventable. If prevented, a saving to the public will be made of $500,000,000 annually.

We, therefore, unite for the purpose of bringing about the results stated in the preamble by means of the dissemination of information on this subject, which should lead to an awakening of public interest and create a demand by the public for Governmental action. In furtherance of this subject, we solicit the coöperation of the public as well as all civic and engineering bodies, and pledge ourselves to collect and distribute data on this subject as to the best means of accomplishing the economies sought.

Resolved: That the Conference shall become an incorporated association with the usual officers and directors as soon as 100 representative firms shall become contributing members.

There shall be appointed by the chairman an executive committee of ten, which shall conduct the campaign for membership and draw up a constitution and by-laws for presentation to the next conference.

Upon the election of the permanent officers, the executive committee shall be dissolved.

The permanent officers and directors shall thereafter direct the affairs of the association as is usual in accordance with the constitution and bylaws adopted by the conference.

The preceding report was accepted with enthusiasm and further procedure will be based on its contents. It was realized that Government supervision of mining, transportation and efficient utilization of fuel in the power plant would not be possible without an ample appropriation from the Congress and the passage of a bill authorizing the Bureau of Mines to conduct the work. An extended educational program would first be necessary to create public sentiment and bring it to bear for such action. The campaign would be of such a nature as to acquaint the coal-using public with the possibilities of conservation and saving in the power plant. It was to be triple-barreled, reaching the management, the engineering department and the men operating the equipment. Aid would be sought from civic bodies, such as chambers of commerce, and from engineering societies, particularly that of the four great founder societies through the consulting engineers committee advisory to the Bureau of Mines, which has been made a permanent organization.

The committees were to be retained and each was to be representative of all manufacturers in that particular branch. The executive committee would call on these branch committees for authentic information telling the public of the savings that were possible and how the product should be utilized to secure maximum economy. These men were experts in their particular line, had the information and were in a better position, possibly, than anyone else to give out such desirable data. It was realized that commercialism must not be allowed to creep in, and one of the functions of the executive committee would be to eliminate any tendencies of this character.

The first efforts, then, of the new association are to be an educational program showing up the possibilities of conservation and the influence the various products manufactured will have on efficiency. In time it is hoped that this information will create sufficient public sentiment to insure through the Congress, Federal supervision.

As to methods to be followed in this supervision no definite program was outlined, but David Moffatt Myers, former consulting engineer to the Fuel Administration, was present and gave from his previous experience a summary of what he considered essential. By careful Governmental regulation it was his belief that fully 100 million tons of coal, amounting at an average figure of $6 per ton, to $600,000,000, could be saved, where an annual appropriation of perhaps $1,000,000 would cover the expense of this regulation.

He considered the Bureau of Mines as the most authoritative source of information in the country on fuels and their conservation. The Geological Survey had made careful study and survey of the possibilities of extending the use of water power These two branches of the service are coördinated under the Secretary of the Interior and are the logical means of handling the problem from headquarters in Washington. A salaried engineer should be appointed by the Department of the Interior to hold office in each state and report to Washington to keep the central bureau of conservation informed on local conditions. The state engineers would keep in touch with industrial developments in their respective territories, interest themselves in the problems involving conservation and bring about the closest touch between local industries and the clearing house of information in Washington.

As an additional and essential feature an advisory body of engineers would assist materially in keeping the Bureau in close touch with the problems and developments of the country and would assist in recommending policies for the Bureau.

By the proposed organization encouragement should be given to new developments leading to economical use of fuel for power generation and for other purposes; such, for example, as the recovering and utilization of the byproducts of coal resulting from low-temperature distillation. No raw coal should be burned under boilers.

Five Engineering Societies Have Amalgamated With A. A. E.

Action by the 300 members of the 25-year-old Engineers and Architects' Association of Southern California, Oct. 25, in becoming the Los Angeles chapter of the American Association of Engineers, although it retains its name, marks the fifth organization that has taken this step within a few months. The Oregon Society of Engineers, a state society, amalgamated with the Portland chapter to form the Oregon Chapter of A. A. E.; the Houston Engineers' Club became the Houston chapter; the Navy Technical Association was taken over and split up, members in New York, Philadelphia and other seaports becoming sections of the local chapters. One of the late developments is the Southwest district, into which the Southwestern Society of Engineers has been formed. Eventually there will be several chapters in this district. The district will cover West Texas, New Mexico and Arizona. The old organization was a low fee one-or-two-meeting-per-year society, but since the dues have been raised and new welfare work has been taken on, the membership has grown from about 175 to more than 400. All of the above organizations have become part and parcel of the A. A. E., not simply affiliated with it, as is the arrangement local chapters have with the Associated Engineering Societies of St. Louis and with the Cleveland Engineering Society.

The Purchase of Coal on Specification

On Nov. 17 at a joint meeting of the Mechanical Engineering Section of the Western Society of Engineers and the Illinois Chapter of the American Society of Heating and Ventilating Engineers, the above topic was discussed from the standpoint of the purchaser and from the position of the coal operator. John Howatt, chief engineer, Chicago Board of Education, and president of the Illinois Chapter of the American Society of Heating and Ventilating Engineers, took the purchasers' viewpoint, and Edward H. Taylor of the Crerar Clinch Coal Company spoke for the operators.

In the primary paper of the evening Mr. Howatt reviewed the various forms of specifications used in the purchase of coal. Due to the expense involved in the checking up of complicated specifications the user of small quantities of coal is forced to buy his fuel on a general specification as to size and grade only. This method of purchasing coal is all in favor of the coal dealer, and under normal conditions should never be resorted to by corporations or institutions that purchase coal in sufficient quantities to warrant the expense of checking and testing deliveries. Years ago specifications of different forms were prepared and put into use, the more common being the specification and award of contract for coal on a guarantee of coal of a definite size from a definite specified mine. This form of purchase is still used extensively, but is open to the objection that in case of accident or shutdown of the particular mine, the purchaser is forced on the open market without protection. Furthermore, it is almost impossible to check the origin of all deliveries, especially if they be made by wagon to many points, so that a poor grade of coal might easily be substituted in some of the deliveries.

At one time attempts were made to purchase and pay for coal on evaporative tests. The bidder that agreed to evaporate the greatest number of pounds of water per pound of coal as received being awarded the contract. It was presumed that the contractor would deliver coal of the same quality as the sample furnished for test throughout the life of the contract. The method proved cumbersome, loose and possible of uncertain results, and in practice it was found difficult to prove the quality of the coal, based upon such tests when controversy arose.

This type of specification has been largely superseded among purchasers of large quantities of coal by a specification in which the purchase is based upon the chemical analysis and heat value of the coal itself. This method is less cumbersome, more scientific and exact and enables a check of results. It is the one method that can be used to compare results of coal of all kinds under boilers in any location. In 1907 the Government started to purchase its coal on this basis, abandoned the method during the war, and again put it into effect last July. Many states, cities and public institutions followed the Government in adopting the B. t. u. method of purchasing their coal supply, varying somewhat in details and methods, but all taking into consideration the quality as well as the quantity of the coal. The cost of coal has risen so much that it is more essential than ever that the purchaser should buy it in accordance with its value to him as a steam maker.

Before making any attempt to prepare a specification for coal, the consumer should try out coals of different sizes and from different coal fields in his boiler plant, and thus obtain information as to what size of coal will give the best results, and from what fields the coal can be used successfully in his furnaces. If analyses of each coal tried are obtained, the consumer will then be prepared to specify the size of coal desired and place limits for ash, moisture and heat value, as the basis of a scientific specification for future purchases on the B. t. u. method. If the coal is specified further to be free of excessive clinkering and to be free burning, the purchaser should be in a position to place contracts for coal not necessarily on the lowest price per ton as bid, but the lowest cost to him for the year's fuel supply. Weak draft or insufficient boiler capacity may of course make it desirable to purchase the highest grade coal regardless of the fact that the price per unit of heat value may be higher.

Taking it for granted that all the coals considered in making a selection are free burning and free from excessive clinkering, there are but three things the purchaser of bituminous coal needs to know; they are its ash content, its moisture content and the heat value or B. t. u. per pound. All formula used in specifications covering the purchase of bituminous coal on the heat value basis should contain these three factors, the first two being loss factors and the last a credit factor on each pound of coal.

The purchaser must bear in mind that the ash content in coal is of considerable importance to him. as he must pay for it at the same rate that he buys the coal, and is subject to the cost of its removal after the coal is burned. Ash naturally reduces the heat value of the coal, and in practice there is a further loss when the ash percentage exceeds a certain limit by reason of the drop in capacity and efficiency of the furnace by the ash deposit clogging the fires. Consequently in the specifications a maximum limit on the percentage of ash should be made, and a penalty for the ash content in coal over the maximum should be provided heavy enough to prevent very much coal of this character being furnished. The penalty should be on a scale that increases rapidly as the percentage of ash increases, and if the ash content is lower than the limit named in the specifications, the contractor should obtain an increased price per ton corresponding to the increased value of the coal.

As a guide for price adjustment to take care of the ash content reference was made to the two typical methods representing latest practice used by the Government and by the city of Chicago. In the Government specifications a standard ash value on a dry basis for the quality of coal it is intended to purchase, is established. Deductions are made from the price to be paid for the coal on a rapidly ascending scale where the ash content is more than 2 per cent. in excess of that named as standard, and a bonus is allowed to the contractor when the per cent. of ash is less than the standard. In the Chicago specification a reduction is made for all the ash in the coal instead of only that in excess of the limits. In this regard it is more scientific, but not as practicable in application at the present time.

Formulæ used in purchasing coal on a B. t. u. basis as a rule make no penalty for moisture other than that provided by reducing the coal delivered to a dry basis. The Government specifications provide for a payment based upon the B. t. u. in the coal as received. The B. t. u. per pound of coal will thus be reduced automatically in proportion to the amount of moisture in it. The city of Chicago specifications provide for payment upon the B. t. u. in the dry coal, but reduces the amount of coal paid for by the amount of moisture in it. The resultant number of heat units in a ton of coal and the price paid the contractor from either specification are therefore identical.

As the B. t. u. per pound varies as much as 30 per cent. between the different commercial Illinois coals, it may be seen that the purchaser can secure what he pays for in heat value only through a method of purchase that bases payment on the B. t. u. per pound of coal. This is the most important factor in all coal purchases made upon analysis.

In writing proposals for coal to be purchased, limits for B. t. u. per pound should be named far enough apart so there will be plenty of opportunity for competitive bidding and still limiting the coal to the general quality desired. The speaker told how the Government and the city of Chicago compared bids on this basis and gave the formulæ by which the price of the coal was determined.

Securing of representative samples for analysis the speaker admitted was the most difficult part of the entire operation when buying coal on the B. t. u. basis. Rules had been established governing the taking of samples which were explicit enough and if strictly followed would result in fair samples being taken; yet it was easy for the sampler to be careless or even dishonest with results in favor of either contractor or purchaser. A careful selection of samplers of intelligence and unquestionable integrity was the best safeguard for both parties. For explicit directions in taking samples that would be representative of the entire lot of coal, reference was made to technical paper No. 133, published by the Bureau of Mines and prepared by George S. Pope.

To guard against failure of the contractor in complying with specifications, the contract should be specific on what conditions the purchaser has the right to reject a delivery of coal, and under what conditions there may be a forfeiture of the contract. The specifications also should provide under what conditions the purchaser has the right to obtain coal from another dealer and charge the difference in cost, if any, against the contractor's account. No institution should place its contract for coal with a concern that has previously failed to meet its obligations, or has not the means or facilities to properly carry out the contract under adverse circumstances.

The writer had nearly ten years' experience in the purchase of coal, and had made purchases on all the different methods. Based upon his experience he was convinced that public institutions at least should purchase their coal on the B. t. u. basis, as had been outlined, until some better scientific method was developed that would provide protection for both buyer and seller. The advantages could not be summarized better than in the six paragraphs of the Bureau of Mines Bulletin No. 41, which follow verbatim:

1. Bidders are placed on a strictly competitive basis as regards quality as well as price. This simplifies the selection of the most desirable bid and minimizes controversy and criticism in making awards.

2. The field for the purchaser and the seller is broadened, as trade names are ignored and comparatively unknown coals offered by responsible bidders may be accepted without detriment.

3. The purchaser is insured against the delivery of poor and dirty coal and is saved from disputes arising from condemnation based on visual inspection.

4. It is not always expedient to reject poor coal because of difficulty, delay and cost of removal. On the B. t. u. system rejectable coal may be accepted at a reduced price.

5. A definite basis for the cancellation of the contract is provided.

6. Being paid for on the penalty basis incites the contractor to prepare coal more carefully.

Speaking for the coal operators and distributors, Mr. Taylor gave the following objections to heat value specifications in coal contracts:

1. That the contracts as drawn are not mutual.
2. That the terms of settlement are based on the assumption that all samples taken are truly representative of the quality of the coal delivered. This the coal operators contend is not a fact.
3. That the contracts so operate that deductions made for the delivery of coal below contract grade is greater than the loss actually sustained, making such deductions, therefore, a penalty instead of liquidated damages.
4. Heat value specifications offer an opportunity for graft and shakedowns on the part of the buyer's representative, and the same opportunity for bribery and trickery on the part of the contractor.
5. Such a contract promotes and fosters unfair competition which works to the detriment of both the buyer and the contractor.

From the various experiences of the operators, numerous cases were cited to make clear their reasons for the objections given. Taking samples that were truly representative of the quality of the coal delivered was the great bugbear, and in addition there were few laboratories properly equipped with instruments standardized to insure accuracy. The coal operator had no redress, as the testing was in the hands of the buyer and testing of the coal by third parties would add considerably to the price of the fuel. What was needed was a closer relationship and more confidence between the buyer and the contractor. The latter fully realized the value of the proximate analysis, as he used it himself when sinking a mine to decide whether the coal was of such quality as to be worth mining. The contractor also believed that the proximate analysis was valuable for identification, as he used it for that purpose, and was of the opinion that proximate analysis and sample taking were sufficiently accurate for this work.

It was the contractor's belief that the buyer should select the coal best suited for his needs after having tested it in his plant to his own satisfaction, and then ask for bids on the grade of coal desired—not for bids on any kind of coal. The Retail Coal Merchants' Association of Chicago was now working on a plan of grading the various kinds of coal with regard to quality that came into the Chicago market. Each grade is to be designated by letter and the quality of the coal as shown by proximate analysis is to come within the limitation described for each grade. With proper co-operation between buyer and contractor a satisfactory grading of coal could be effected in this way, so that the buyer could ask for bids on grades A, B or C as may be desired. After receiving the bids the buyer could contract for his coal f. o. b. mine, pay the freight and get the freight bills, which would prove that he was getting the coal that he purchased.

With wagon delivery of coal the buyer should determine the grade of coal desired and so specify in his contract, reserving the right to reject any coal not coming up to the contract grade. With a reputable contractor he will have no trouble. He should, however, have his coal analyzed and if it does not conform with the grades purchased, reject it and order the coal removed. The latter injunction is important, for if the buyer orders the coal removed he punishes the contractor in a way that will not soon be forgotten. It is the big stick in the buyer's hand that will prevent this practice and, if he holds out against scaling of prices to avoid such a penalty or bribery, fair dealing will be insured.

Chicago Section, A. S. M. E.,Opens Season

On Nov. 21 at the Morrison Hotel in Chicago Section of the American Society of Mechanical Engineers held its first dinner meeting of the season, with Arthur L. Rice, the new chairman of the section, presiding. A good attendance and short and concise treatment of three subjects of general engineering interest made the opener a lively meeting.

Charles B. Burdick outlined the plans that are now under way to reorganize the Department of the Interior into a Department of Public Works, consolidating under one head all building of the Government, amounting to 20 per cent. of the appropriations made by the Congress. Hitherto this work had been done by thirty different bureaus, twelve to fifteen of them of an engineering character tucked away in various departments foreign to their work. With the head of the department non-technical, proper support and sympathy with the work could not be expected, and as a result there has been a lack of co-operation, needless duplication and delay. Concentrating these various engineering bureaus under one department so that all Government building may be conducted efficiently and with less expense is now the joint work of 74 different engineering societies. At a conference last May in Chicago an organization was perfected to bring about the foregoing. Since that time the Jones-Reavis bill that will make these plans possible has been drafted and in the legislature has been assigned to committees, where it now rests in accordance with the wishes of those responsible for the bill until sufficient public sentiment can be created to put it through.

For the latter purpose there will be a "back-home" campaign in every state of the Union. Each state will have a director and organization to raise money first to conduct the campaign, and then spread publicity on the merits of the bill to every voter in the state, the voter, in turn, to convey his impression to the senator of his respective district.

W. L. Abbott, director for Illinois, reported that the state organization in great detail was now being perfected.

"Results of an Americanization Program," by Alexander D Bailey, was the second topic of the evening. The speaker dwelt upon the need of such a program and outlined briefly the results so far obtained. In simple words, the program consisted of making good American citizens out of our foreign-born. It was a problem requiring full knowledge of American ideals and an aptitude in teaching them. It consisted not only of a matter of schooling, but also prevention of exploitation, good wages, good housing and other factors influencing the welfare of the foreigner. That the foreign-born had not been assimilated in the past was made evident by the radical demonstrations now raging. Their instruction had been left too much to the individual citizen, instead of definite concerted action toward a common end. One of the greatest bars to assimilation was the inability of so many foreigners to talk

English, making them an easy prey for radical propaganda and the more vicious of the foreign language papers. It was surprising to note that of the entire population of Chicago 55 per cent. were either foreign born or not naturalized. To intelligently instruct so great a number in the requirements of good citizenship and bring them into closer acquaintance with our form of government was a task of great magnitude. Mr. Bailey reviewed briefly the work being done along this line and the results obtained by the Commonwealth Edison Company of Chicago.

Charles S. Scribner, in a brief discussion, outlined the principal methods that had been applied successfully to improve human relations. The topic was limited to the relations between the employer and the employe, the principles involved being divided into two groups: those that have to do with the welfare and feelings of the men and those relating to the distribution of wealth between capital and labor. Selection of employes, their surroundings, acquaintance with other workers and their promotion; healthful conditions in the factory, guards against accidents, attitude of foremen, and general relations between the worker and the employer; collective bargaining, an industrial committee made up from the workers and representatives of the employers, shop discipline, wage payment and wage incentive, etc., were some of the various points touched upon by the speaker.

Having outlined the fundamentals of the problem that have to be solved before the present industrial unrest will be subdued, the speaker referred to the industrial democracy plan that is now receiving so much attention.

Among certain of those taking part in the discussion there was a sentiment that the laborer must first show the proper spirit, take a real interest in his work, learn and appreciate industrial democracy, before it was given to him. With radical agitators in full sway many of the workmen would not understand nor would they appreciate a sudden turning to this new scheme. It was a matter that required careful consideration and long hard work in training and instructing employes in the elementary principles involved. When they had assimilated the fact that it was up to them to give fair returns for money received, and when they took a real and intelligent interest in their work, then would be the time to share profits and introduce the plan of industrial democracy.

Naval Architects and Marine Engineers Meet

The Society of Naval Architects and Marine Engineers held its twenty-seventh general meeting at the Engineers Society Building in New York Nov. 13 and 14.

The council meeting preceded the general meeting and the latter was devoted principally to the presentation and discussion of profession papers. In opening the professional session, the president of the society called attention to the recent enormous growth in American shipbuilding. Referring to past presidential addresses, he noted the satisfaction expressed over the situation in 1900 when 80 steel steam vessels of 168,000 tons were built as compared with Great Britain's figures of 567 vessels of 1,341,000 tons. In 1908 America built 1457 vessels of 614,000 tons, and this was hailed as the greatest output in the history of the country. In the fiscal year 1919 the figures given include only steel steamers of over 1000 tons, but reached the total value of nearly 2,500,000 tons.

The professional sessions occupied Thursday and Friday the 13th and 14th and on Saturday, Nov. 15, a trip to the works of the Submarine Boat Corporation was arranged for members and their guests. The meeting closed with the annual banquet which was held at the Waldorf-Astoria Hotel

DeLamater-Ericsson Memorial

The American Society of Mechanical Engineers with a large number of technical societies and civic organizations will hold a memorial meeting at 8 o'clock on the evening of Dec. 3 at the Engineering Societies Building, 29 West 39th Street, to commemorate the Phœnix Foundry, which stood on West Street between Vestry and Laight Streets, 1838-51, and the DeLamater Iron Works at the foot of West Thirteenth Street, 1851-89, in both of which under Cornelius H. DeLamater and Capt. John Ericsson was developed the progress in naval architecture and industrial engineering which occurred during those years. Tablets will be erected on these sites. People who possess prints or documents relating to these works will confer a favor upon the committee by communicating with H. F. J Porter, chairman, DeLamater-Ericsson Memorial, A. S. N. E., 29 West Thirty-ninth Street.

Personals

John C. McCabe, commissioner of buildings for the City of Detroit, gave an informal talk before the Detroit Engineering Society, in the auditorium of the Detroit Board of Commerce, on Sept. 19, on the "Detroit Building Code and the Organization of the Building Department."

Franklin W. Gilman, combustion engineer with the Sanford Riley Stoker Co., of Worcester, and the Murphy Iron Works of Detroit, sailed from Vancouver on Oct. 2 for Japan. He will remain in that country for about a year in connection with the installation and operation of stokers manufactured by the two companies.

L. G. Chase, formerly efficiency engineer of the Rosemary Manufacturing Co., Rosemary, N. C., has been appointed mechanical engineer of the Yarnall-Waring Co.

E. H. Martindale has resigned as sales engineer of National Carbon Co. to accept a position as president and general manager of The Handy Supply & Manufacturing Co., Cleveland, Ohio, in which he has been interested in an advisory capacity for three or four years.

A. G. Gibbons, formerly superintendent of tools and supplies of Winslow Brothers Co., Chicago, has affiliated with the Wetmore Reamer Co. in the capacity of production engineer. Mr. Gibbons was also formerly with the Cadillac Co. and Brown & Sharpe for many years.

Nelson B. Gatch has been appointed district manager of sales of the Chicago Pneumatic Tool Co., with headquarters at 52 Vanderbilt Ave., New York City, to succeed L. C. Sprague.

H. W. Philbrook, formerly connected with the General Electric Co., Schenectady, is now district manager of the New York office of Schutte & Koerting Co.

W. D. Hoxie, formerly vice-president of the Babcock and Wilcox Co., New York City, has been elected president.

Business Items

The S-T Engineering Corp., of Buffalo, N. Y., has been incorporated with a capital of one hundred thousand dollars. The company will manufacture and sell mechanical equipment.

The Jacobson Engineering Co., Inc., Albany, N. Y., has opened an office at 30 Church St., New York, which will be the main sales office in future, both for domestic and export business.

The Roller-Smith Co., New York City, announces the appointment of the Alfred Collyer Co., 420 Power Building, 83 Craig St., West, Montreal, Canada, as its agent for the entire Dominion of Canada and Newfoundland. The Alfred Collyer Co. has a branch office at 183 George St., Toronto.

The General Electric Co. has leased the rigid-conduit business of the American Conduit Manufacturing Co. of New Kensington, Penn., which will be conducted by the Sprague Electric Works. There will be no change in the personnel of the American Conduit Manufacturing Co., but the name will be changed to the American Wiremold Co., which will concentrate upon the manufacture of wiremold surface raceway and non-metallic tubing, at Hartford, Conn.

The Chicago Pneumatic Tool Co. has moved its Birmingham office from 801 Brown Marx Building to 1925 Fifth Ave., North, where a service station with a complete stock will be maintained.

The Shipley Construction & Supply Co., Brooklyn, N. Y., has extended its service for industries using refrigerating and ice making equipment, by establishing branch offices at 659 Broadway, Albany, N. Y., and 209 Wood's Building, New Haven, Conn.

The Zobell Electric Motor Corp., Garwood, N. J., is a newly formed corporation which manufactures alternating current and direct current motors, in sizes ranging from 1 to 7½ horsepower.

Trade Catalogs

The Gould's Manufacturing Co., Seneca Falls, N. Y., has issued a 36-page bulletin, No. 122, entitled "Centrifugal Pump Sales Service Data." This was originally issued in a series of sales letters for use in the company's own organization. It contains a lot of information on theory, designs, testing, etc., of centrifugal pumps not published heretofore.

The Taft-Pierce Manufacturing Co., Woonsocket, R. I., has recently issued a nicely finished 47-page bulletin, No. 108, entitled "Take It to Taft-Pierce." It is briefly descriptive of the company's contract service plant, which has engaged in practically every important machine manufacturing development that has taken place in this country. Illustrations are liberally used in the bulletin.

The National Tube Co., Pittsburgh, Penn., has issued its September bulletin, No. 7, which treats of the manufacture and advantages of "National" welding-scale free pipe in a simple interesting way. The bulletin is well illustrated and will be sent to anybody free upon request.

The Yarnall-Waring Co., Philadelphia, Penn., has issued a 22-page bulletin illustrating and fully describing the Yarway-Lea V-Notch Liquid Meter. The booklet is entitled "Boiler Room Records and the Yarway-Lea V-Notch Meter," a copy of which should be in every operating engineer's possession.

The American Steam Conveyor Corp., Chicago, Ill., has issued a folder entitled "A Pertinent Ash Pile Question," which advances arguments favoring the use of its steam ash conveyor in power plants, and shows the savings that can be accomplished through its use.

The Alberger Pump and Condenser Co., New York City, has issued a 63-page catalog "F" on "Alberger Centrifugal Pumps and Curtis Steam Turbines," which illustrates and fully describes the various types manufactured by this company.

New Construction

PROPOSED WORK

Ala., Gadsden—The city plans an election to vote bonds for the construction of an electric distribution system. E. Smith, City, Engr.

Conn., Bridgeport—The Columbia Grafanola Co., Barnum St., plans to build a 5 and a 6 story factory on Barnum St. and Howard Ave. A steam heating system will be installed in same. Total estimated cost, $1,750,000.

Conn., New Haven—The city voted $500,000 bonds to erect an ice plant.

Cal., San Francisco—C. R. McCormick & Co., Fife Bldg., desires to purchase Babcock-Wilcox boilers.

Ia., Iowa City—The State Board of Control, Hubbell Bldg., Des Moines, is having plans prepared for the construction of a 3 story, 60 x 130 ft. nurses' home. A steam heating system will be installed in same. Total estimated cost, $150,000. Proudfoot, Bird & Rawson, Hubbell Bldg., Des Moines, Arch.

Ia., Iowa City—The State Board of Education, Des Moines, is having plans prepared for the construction of a 3 story, 90 x 180 ft. armory, here. A steam heating system will be installed in same. Total estimated cost, $200,000. Proudfoot, Bird & Rawson, Hubbell Bldg., Des Moines, Arch.

Ia., Larabee—The Board of Education is having plans prepared for the construction of a 3 story, 82 x 139 ft. school. A steam heating system will be installed in same. Total estimated cost, $130,000. H. Montgomery, Secy. W. E. Hulse & Co., 210 Masonic Temple, Des Moines, Arch.

Ia., Olds—The Board of Education is having plans prepared for the construction of a 2 story, 62 x 150 ft. consolidated school. A steam heating system will be installed in same. Total estimated cost, $110,000. J. E. Stuckey, Secy. Keffer & Jones, 204 Masonic Temple, Des Moines, Arch.

Ia., Sioux City—The Sioux City Hotel, c/o W. Gordon, is having plans prepared for the construction of an 8 story, 150 x 150 ft. hotel on 7th and Pierce Ave. A steam heating system wil be installed in same. Total estimated cost, $1,500,000. Marshall & Fox, 721 North Michigan Ave., Chicago, Ill., Arch.

Kan., Emporia—The State Board of Education, Topeka, is having plans prepared for the construction of a 1 story power plant, including equipment, for the State Normal School, here. Estimated cost, $70,000. J. A. Kimball, Mgr.; R. L. Gamble, 1415 Fillmore St., Topeka, Arch.

Ky., Frankfort—The Capitol Hotel Co. will receive bids until December 1 for the construction of a 5 story hotel. A power plant will be installed in same. Total estimated cost, $200,000. C. C. Weber, 3rd and Walnut Sts., Cincinnati, Ohio, Arch.

Md., Baltimore—The Kaufman Beef Co., Union Stockyards, 6th St. near Wilkens Ave., is having plans prepared for the construction of a 2 story, 40 x 150 ft. packing house and power house. A steam heating and electric lighting system, elevators, refrigerators, etc., will be installed in same. Total estimated cost, $100,000. C. H. A. Wannanwetsch, 563 William St., Buffalo, N. Y., Engr.

Md., Baltimore—The Misken Israel congregation is having plans prepared for the construction of a 2 story, 50 x 130 ft. synagogue at 2310 Madison Ave. A steam heating system will be installed in same. Total estimated cost, $150,000. A. Kress, 2318 Eutaw Pl., Pres. Stanislaus Russell, 11 East Lexington St., Arch.

Md., Baltimore—The City Council is having plans prepared for the construction of a 1 story fire house on Lexington St. near Gay St. A steam heating system will be installed in same. Total estimated cost, $150,000. A. Osborn, City Hall, Arch.

Md., Sparrows Point—The Bethlehem Ship Building Corporation plans to construct a dry dock, to be driven by electric power. Swen Anderson, Gen. Mgr.

Mass., Boston—The Merchants National Bank., 28 State St., will receive bids this winter for the construction of a 5 story, 54 x 222 ft. bank addition on Devonshire St. A steam heating system will be installed in same. Total estimated cost, $500,000. Coolidge & Shattuck, 122 Ames Bldg., Arch.

Mass., Chicopee—The Springfield Coach Works, 59 Dwight St., will alter present factory and build a boiler house on North Main St. Two boilers will be installed in same. Work will be done by day labor. Total estimated cost, $25,000.

Mass., North Adams—The Y. M. C. A., 2 West 45th St., New York City, is having plans prepared for the construction of a building, here. A steam heating system will be installed in same. Total estimated cost, $250,000. Jallade & Lindsey, 37 Liberty St., New York City, Arch. and Engr.

Mich., Detroit—The General Motors Corporation, 435 Woodward Ave., is having plans prepared for the construction of a 26 x 26 ft. pump house, also furnishing and installing 5 motor driven oil pumps for circulating oil in the heat treating and hardening plant. Esselstyn, Murphy & Hanford, Marquette Bldg., Engr. Noted June 3.

Mich., Detroit—The Board of Education, 50 Broadway, is having plans prepared for the construction of the Park School, Milwaukee Ave. and East Grand Blvd.; Greusel School, Moran and Medbury Ave., and Capron School, Maple and Riopelle St. The plenum system of heating will be installed in same, boiler, pump, fan and motor involved in each case. Total estimated cost, $150,000. Malcolmson & Higginbotham, 405 Moffat Bldg., Arch.

Mich., Detroit—S. E. Remey, Arch., 503 Whitney Office Bldg., is preparing plans for the construction of a 6 story, 47 x 52 ft. office building on Hastings and Erskine Ave. A steam heating system will be installed in same. Total estimated cost, $100,000. Owner's name withheld.

Mich., Detroit—The Superior Machine & Engineering Co., East Larned St., is having plans prepared for the construction of a 5 story, 100 x 104 ft. factory. Steam heating equipment and electric motors for power will be installed in same. Brown & Preston, 406-8 Empire Bldg., Arch.

Mich., Detroit—The John R. Thompson Auto Co., Woodward Ave., has retained Albert Kahn, Arch., Marquette Bldg., to prepare plans for the construction of a 2 story, 400 x 700 ft. commercial auditorium on Woodward and Cass Ave. A ventilating system and steam heating equipment, with accessories, will be installed in same. Total estimated cost, $2,500,000.

Mich., Ferndale—G. D. Bader, 3002 Woodward Ave., will build a 2 story, 80 x 100 ft. commercial building on Woodward Ave. A steam boiler for heating purposes will be installed in same. Total estimated cost, $60,000. Work will be done by day labor.

Mich., Grand Rapids—The Regent Theatre Co., Bond St., is having plans prepared for the construction of a 3 story, 100 x 100 ft. theatre on Crescent and Bond St. A steam heating system will be installed in same. Total estimated cost, $300,000. George M. Lindsey, 2321 Dime Bank Bldg., Detroit, Arch. and Engr.

CONTRACTS AWARDED

Cal., Los Angeles—The University of Southern California, College of Liberal Arts Bldg., 35th and University St., has awarded the contract for the installation of a heating and ventilating system in connection with the proposed 3 story college building, to Thomas Haverty Co., 9th St. and Maple Ave., $27,980.

Conn., Willimantic—The State Board of Education has awardtd the contract for installing a heating system, in the proposed 3 story dormitory on Valley St., to R. R. Bell & Co., 59 Fort St., Springfield, Mass. Noted Feb. 4.

Ill., Amboy—The Amboy Milk Products Co. has awarded the contract for the construction of a 2 story, 97 x 153 ft. condensory to the Appleton Construction Co., Odd Fellows Bldg.

Ia., Muscatine—The Masonic Lodge has awarded the contract for installing a steam heating system in the proposed 3 story, 55 x 120 ft. Masonic Temple, to the percentage Lotspeich Co., Muscatine. Total estimated cost, $120,000.

Kan., Willis—The city has awarded the general contract for the construction of a distribution system and a transmission line from here to Horton, to C. R. McConnel, Horton, $18,490; transmission and motors to C. L. Millbank, Interstate Bldg., Kansas City, Mo., $1350. Noted Sept. 30.

Md., Baltimore—A party of capitalists of Richmond, Va., and Washington, D. C., have awarded the contract for the construction of an 18 story, 180 x 250 ft. hotel on Charles and Chase St., here, to the Wise Granite & Construction Co., American National Bank, Richmond, Va. Subbids to be let on steam heat, electric light, elevators, vacuum cleaning, refrigerators, etc. Total estimated cost, $1,500,000.

Mass., Springfield—The United Manufacturing Co., 57 Willow St., has awarded the contract for the construction of a 1 story boiler room on Birnie Ave. to D. W. Mellen, 293 Bridge St. Estimated cost, $25,000.

Mich., Birmingham—The city is having plans prepared by C. W. Hubbell, Engr., 2348 Penobscot Bldg., Detroit, for the construction of a water system consisting of 12 in. wells and two motor driven centrifugal pumping units, etc. Total estimated cost, $75,000.

Mich., Detroit—The Detroit Edison Co., David Whitney Bldg., has awarded the contract for the construction of a 2 story, 100 x 207 ft. service station on Ledyard and 2nd St., to the Albert A. Albrecht Co., 1130 Penobscot Bldg. A steam heating system will be installed in same.

Mich., Detroit—The Eastern Motor Sales Co., 404 Gratiot Ave., has awarded the contract for the construction of a 3 story, 115 x 143 ft. service station on Gratiot Ave., to the Otto Misch Co., Chamber of Commerce, Detroit. A hot water heating system will be installed in same. Total estimated cost, $50,000.

Mich., Detroit—The Fisher Body Corporation, Oakland Ave. and Piquette St., has awarded the contract for the construction of a 1 story, 57 x 64 ft. power house on Theodore and Riopelle St., to G. A. Fuller Co., 540 Penobscot Bldg. Two vertical boilers, 250 h.p. each, will be installed in same. Total estimated cost, $45,000.

Mich., Detroit—The Fisher Body Corporation, Oakland Ave. and Piquette St., has awarded the contract for the construction of a 1 story power house, on Trombley St., to Montague & Forney, 813 Ford Bldg. Total estimated cost, $80,000.

Mich., Detroit—The General Aluminum & Brass Manufacturing Co., St. Aubin Ave., has awarded the contract for the construction of a 1 story, 60 x 75 ft. power house, on St. Aubin Ave. and Boulevard, to the Carlton Construction Co., St. Aubin Ave. Two 250 h.p. Wickes boilers will be installed in same.

Ohio, Cleveland—The White Sewing Machine Co., East 79th St. and St. Clair Ave., has awarded the contract for the construction of a 1 story, 32 x 40 ft. temporary boiler house, to the Watson Engineering Co., 1101 Hippodrome Bldg. Estimated cost, $7000.

Mich., Detroit—The Burroughs Adding Machine Co., 2nd and Burroughs Ave., has awarded the contract for the construction of a 2 story, 97 x 99 ft. boiler room, to A. J. Smith Construction Co., Campaw Bldg. Two boilers and condensers, three turbine engines and one conveyor will be installed in same.

Mich., Saginaw—The Michigan Crankshaft Co. has awarded the contract for the construction of a 1 story, 160 x 690 ft. crankshaft plant on Genesee Ave. and Pere Marquette Railway, to W. F. Wood Co., 1805 Ford Bldg., Detroit. Plants include a 50 x 94 ft. power plant, containing two 500 h.p. boilers, with coal crusher, automatic stokers, engines and pumps. Total estimated cost, $600,000.

Wis., Milwaukee—The Gridley Dairy Co., 138 8th St., has awarded the contract for the construction of a 39 x 55 ft. boiler house, at 1325 North Ave., to Dahlman Construction Co., Majestic Bldg. Estimated cost, $15,000.

Wis., Milwaukee—Robert A. Johnson Co., 270 Florida St., has awarded the contract for the construction of a 1, 2, and 3 story, 120 x 185 ft. power house and garage, on 34th St. and National Ave., to Paul Riesen's Sons, 1018 Humboldt Ave. Steam heating and power equipment will be installed in same. Total estimated cost, $90,000.

Ia., Creston—The Board of Education has awarded the contract for installing a steam heating system in the proposed 2 story, 52 x 81 ft. school, to R. C. Wilbee, Creston, $15,823.

Minn., Fairmont—The city has awarded the contract for the construction of a 1 story, 83 x 83 ft. electric power house, to J. G. Robertson, 2528 University Ave., St. Paul. Estimated cost, $175,000. Noted September 30.

Kan., Pretty Prairie—The city has awarded the contract for furnishing and installing pumps, in connection with the proposed water works system, to the American Well Works Co., 319 Reliance Bldg., Kansas City, Mo., $2722.

H. T., Pearl Harbor—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of a boiler house, to C. L. Wold Co., 40 Montgomery St., San Francisco, Cal., $363,889.

Ont., London—J. and J. Allen, Richmond and Victoria Sts., Toronto, have awarded the contract for the installation of a vacuum steam, electric operated blower ventilating system in the proposed 1 story 100 x 180 ft. motion picture theatre, to A. Welsh & Son, Ltd., 304 Queen Ave., Toronto. Noted April 8.

POWER

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The Prescription

OLD DOC COMMON SENSE looked over the rims of his glasses at the lugubrious face of his caller.

"What seems to be the trouble?"

"I don't know," groaned the visitor. "I just ain't able to take any interest in life."

"Appetite good?"

"Fair."

"Pain anywhere?"

"Not a bit."

"Any chills?"

"My feet get cold," admitted the patient.

"Fever, too?"

"Sometimes my head gets hot."

"Um-m-m," mused the Doc. "Hot head and cold feet. Bad symptoms — very bad. Got plenty of pep?"

"That's just the trouble," said the sick man. "Im always tired—never want to keep at a job till it's done."

"Been plugging along pretty steady, have you?"

"Well, not so hard of late. I sort of let up a bit after the war stopped."

"Still put in eight to twelve hours a day, and five to six days a week, eh?" pursued the Doc.

"Well, not quite," answered the patient, beginning to fidget. "Say five or six hours a day and four or five days a week. You see, Doc, I feel so tired——"

"Yes, I know," interrupted the doctor. "And how about your nights? Go to bed early and get plenty of sleep?"

"Well, no; not exactly. You see, my wife she likes theaters, cabarets and motoring, and so on, and I try to please her."

The Doctor slowly brought the tips of his fingers together. Then he cleared his throat ominously.

"I suppose you want me to tell you the truth," he said.

"Sure. I want to know what's ailing me," declared the sick one. But his lips twitched and a frightened look filled his eyes.

"Well, then," the Doc continued, "I'd say you are on the verge of a breakdown. If you keep on at your present pace, I'll not answer for the consequences."

"Ain't there any hope, Doc?"

"Lots of it," reassured the doctor. "You've got a good constitution, but you've got to change your habits. Will you do exactly as I tell you?"

"Sure, Doc!" the patient agreed with alacrity.

"All right, then. I'll give you a prescription, and instead of Latin camouflage and flubdub, I'll put it in plain American, so you can see for yourself that I'm not flimflamming you."

He pulled out his pen, wrote steadily for a minute or two, and handed the writing to the expectant patient. Herewith is the prescription:

COM. N. SENSE, M. D.

Quit killing time—it's a polite form of murder.

Stay on the job eight hours and work every hour of it.

Rest eight hours a day. (You'll have to, if you obey the last paragraph.)

Stop yelling for shorter hours with higher pay. Thirty hours a week won't feed and clothe you.

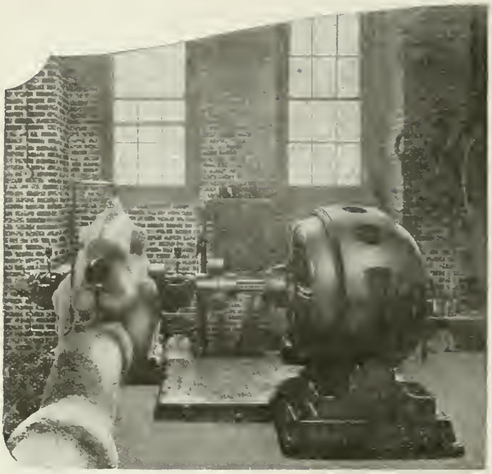
Knock the false doctrines out of your head. Neither laws nor absence of laws can make you happy and contented; but industry, decency and thrift can.

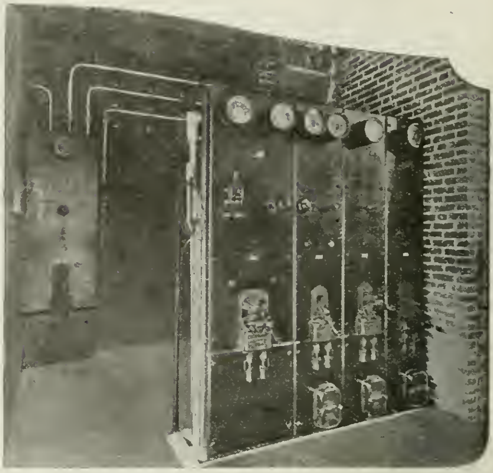
Your ailment isn't physiological—it's psychological. Its name is Laziness and its antidote is Labor.

Quit shamming and malingering.

GO TO WORK!

Contributed by Rufus T. Strohm





The T-Wharf Plant, Quincy Market Cold Storage and Warehouse Co., Boston

By CHARLES H. BROMLEY

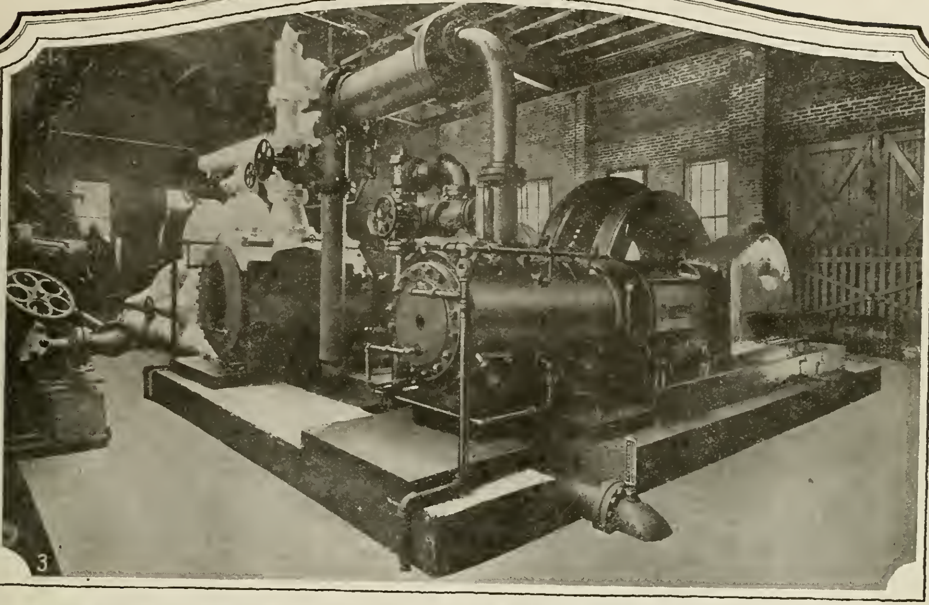
IF Josiah Quincy, who so many years ago froze poultry with salt and ice in that now famous Quincy Market which he gave as a memorial to Boston, could pay the city a visit, he would be both astounded and pleased with the mechanical progress made by the company that bears his name and carries on the work he started. The 1000-ton Quincy Market ammonia compressor excited profound interest and admiration (for complete description see *Power,* Dec. 8 and 15, 1914), but the new electrically-driven, high-speed, feather-valve compressor plant at T Wharf is the most interesting and likely the most valuable piece of refrigerating engineering the country has seen in many a day.

The present building housing the T Wharf station is temporary, the mechanical equipment is permanent. Briefly, the station is of 500 tons rated capacity, in one compound, high-speed, feather-valve ammonia compressor driven by a 600-hp. synchronous motor with energy purchased from the Edison Electric Illuminating Co. There are eight vertical, shell and tube condensers, three horizontal five-pass brine coolers, condensers and coolers being of Quincy Market design. Two induction-motor-driven centrifugal pumps furnish salt water from Boston Harbor for condensing purposes, and one 2200-gal. per min. centrifugal pump, induction-motor-driven, circulates the brine that cools the warehouses. This plant serves seven large warehouses of the Quincy Market Co., the large Clinton Market and several wharf warehouses. See Figs. 1 to 6.

The compressor has a 24-in. stroke, a low-pressure cylinder of 27-in. bore, high-pressure cylinder of 15-in. bore. The low-pressure cylinder has 12 valves, each with a free opening area of 9 sq. in., the high-pressure cylinder 6 valves, each of the same area. At the normal speed of 164r.p.m. the compressor will pump 2665 cu. ft. of gas per minute. The normal suction gas pressure is 5 lb. The compressor in itself is of the standard Laidlaw type, but its gas connections and gas intercooler are of Quincy Market design. The flywheel was selected after studies of statements on flywheel effect with synchronous motors by Westinghouse Electric and Manufacturing Co., General Electric Co. and the Worthington Pump and Machinery Co.—all based on definite crank-effort diagrams, the resultant or final decision being in the nature of a compromise. The slight swing of the ammeter needle indicates excellent all-around balance.

As mentioned, the building is temporary. The piles were cut at the various elevations desired for particular apparatus which they were to support, stringers run across and the apparatus is set upon the stringers.

Now let us go back to the incoming street electrical mains and take up the details of each piece of apparatus in the plant. The station virtually becomes a substation of the Edison Electric Illuminating Co. The current comes to the Quincy Market service switch at 14,000 volts after passing through the Edison company's section of the switchhouse, all fireproof, of course. The transformer is on the Quincy Market line. This is rated at 500 kw., but with ventilation which a 5-hp. fan, soon to be installed, will give, the capacity, even in summer, will be 600 kw. if necessary. All electrical equipment on the Quincy Market side is water- and moisture-proof. That is, a stream of water might be played into the switchhouse, as during a fire, and no short-circuiting would result. The cables are 25,000 volt, and the service switch is an all-inclosed oil switch, remote-controlled. The precipitation of moisture upon the equipment and walls of the switchhouse will not, of course, cause short-circuit. While probabilities of short-circuits due to water and atmospheric moisture may be remote, it is well to provide against them when the load is refrigeration and the demand is for 24-hour daily service, particularly when the volume and value of the stored goods reach the proportions of this warehouse system. Each motor has its own indicating ammeter and integrating wattmeter. These permit of observing



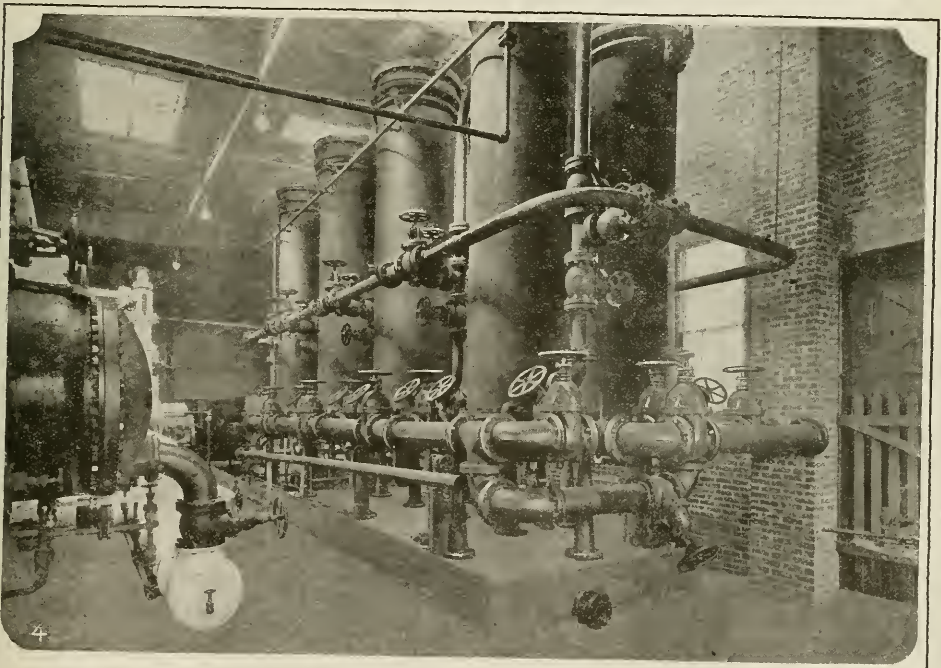


FIG. 3. THE 500-TON HIGH-SPEED, FEATHER-VALVE AMMONIA COMPRESSOR, AND, FIG. 4, THE SHELL AND TABLE CONDENSERS

what effect on current consumption any changes in feeding gas, or brine, or water produces. A Bailey meter will be used on both ammonia suction and discharge to measure gas flow when desired.

A synchronous motor without a heavy flywheel will come up to synchronous speed and lock in without appreciable line surge. The greater the flywheel effect the less this is true; that is, the greater will be the line surge and the more careful the operator must be when he throws on full line voltage, if he would avoid severe line surge. Mr. Fairbanks, chief engineer for the Quincy Market Co., has insured that his operators will do no guessing when making a "shot." Belt-driven from the 15-in. shaft of the compressor (and motor) is a little generator of the kind one sees used so frequently for ignition purposes. When the main motor is at the synchronous speed of 164 r.p.m., a voltmeter-tachometer on the control board and immediately under the line ammeter, magnetized by the little generator, indicates when to throw in full line voltage. This tachometer is not shown in the switchboard view, Fig. 2.

Special Features of Synchronous Motor

The synchronous motor, while not of special design, embodies special features. Any reactive electrical effort coming through the stator of a synchronous motor continues, as lines of force, across the air gap to the rotor when, if the effort is great enough, some member of the rotor—a spoke, the hub, the rim—may fracture. The writer is not here arguing how great such reactive effort might be or how often it may manifest itself; but consideration of this factor led Mr. Fairbanks to modify the design, or rather the materials, of some parts of the standard motor. The rotor, for example, is of cast steel instead of cast iron, giving much greater tensile strength. The bolts holding the coils and those anchoring the motor were increased in size and heat-treated, increasing their elastic limit considerably. Fig. 7 shows plan and elevations of the equipment.

The 15-kw. 125-volt 875-r.p.m. generator for exciting the synchronous motor is belt-driven, as shown in Fig. 5. Exciters for the motors in the permanent plant, when built, will be synchronous and direct-connected.

Now begin with the low-pressure gas in the header immediately above the three horizontal coolers. See Figs. 6 and 8. This header, made of 16-in. pipe, carries a 6-in. dry pipe, both shown in Fig. 8. The dry pipe is welded at each end to a plate that is welded to the header. Notice that the top side—that is, the side opposite the gas-admission side—of the dry pipe has a slit 2 in. wide for its entire length, through which the gas passes into the dry pipe and thence to the suction pipe. To the bottom of the dry pipe is riveted a curved baffle plate which changes the direction of gas flow from the coolers so as to throw out some of the entrained liquid. Both dry pipe and header are given a slight pitch toward the dead end where liquid may drain into the header from the dry pipe and from the header into the coolers. The circular plate in the outlet end of the header has an opening of segment shape into the header, the opening being immediately above that into which the dry pipe is welded and so situated as to pass gas collecting at the top of the header to the suction pipe.

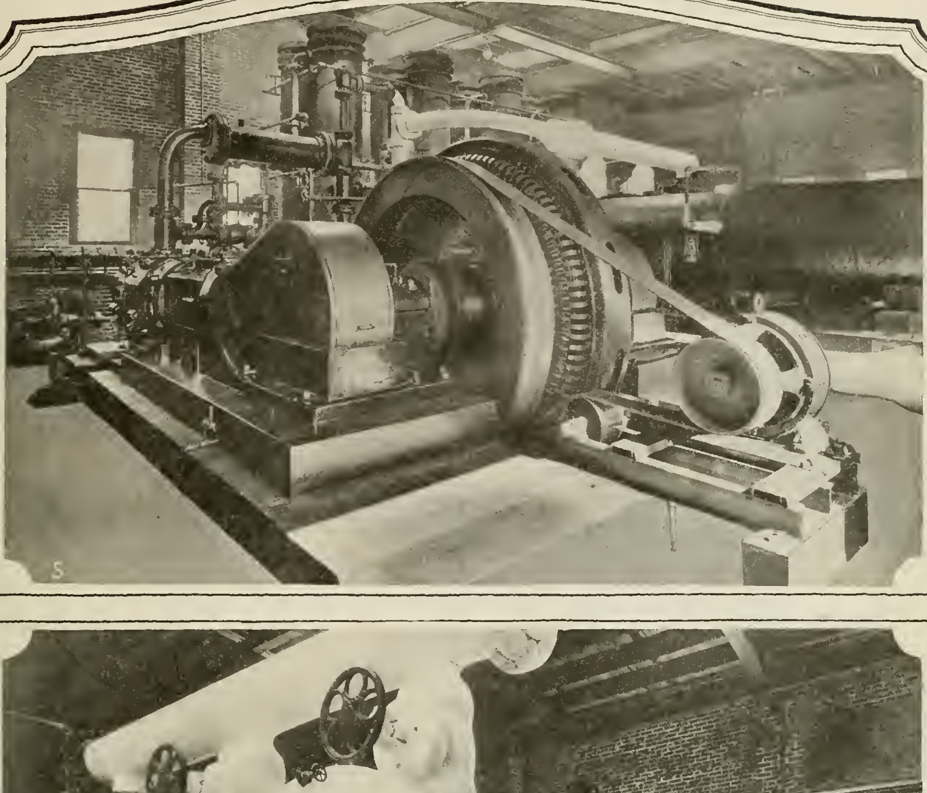
The gas has but about 10 ft. to travel to reach the compressor. This line is horizontal above the compressor, but the drop to the compressor is straight. The suction valves of the compressor are on the top side of the cylinder. The conditions are such that liability to slop over is remote unless the liquid level in the coolers is carried unreasonably high or the feeding of liquid through the expansion (regulating) valves is unnecessarily fast. A slopover here cannot come in one smashing flow; it comes gradually. A large thermometer in the suction line at the low-pressure cylinder immediately indicates that a slopover is trying to take place because the evaporation of liquid from its well sends the mercury down 10 to 15 deg. below the temperature corresponding to the suction pressure. To immediately gasify liquid coming over, the operator has but to open the valve in the bypass between the low-pressure discharge and the suction, admitting hot gas. This, with regulation of the liquid level, is all that is necessary to avoid possible trouble from slopover.

There is a condition, at first surprising, which tends to produce a slopover when the rate of feeding liquid to the brine coolers is suddenly and markedly reduced—not increased, but reduced. The expansion-line nozzle inside the cooler projects the liquid up at an angle on a line with the top far end of the cooler. Feeding may be so rapid that the liquid in the cooler will pile up at this end and thus leave more disengaging volume between liquid level and cooler top at the gas-outlet end than existed before increasing the rate of liquid flow.

A feature of the compressor is the intercooler designed by the purchaser. See Figs. 3 and 8. The cooling medium is liquid ammonia taken direct from the liquid receiver. The principle of the intercooler is identical with that of the open feed-water heater, and the intercooler is provided with trays and baffles just as is the open heater. Liquid direct from the main liquid receiver is run through the intercooler, and what is not evaporated goes to the brine coolers. The gain is, of course, twofold: First, the gas is cooled, reducing the volume to be handled by the high-pressure cylinder; second, liquid in cooling by its own expansion uses up, say, 15 per cent. of its cooling effect in cooling itself. Compared with its condition in the liquid receiver, this liquid passed through the intercooler has already lost this in a more useful way—the liquid as well as the gas has benefited by the heat exchange in the intercooler. As the intercooler pressure is 60 lb. and that in the brine coolers 5 lb., the liquid is trapped just before it reaches the coolers. It is convenient to use the last, or No. 8, condenser as an intercooler, taking the gas before it goes to the liquid-gas intercooler.

A Quincy Market safety valve on the low-pressure cylinder discharge line may blow back into the suction at 125 lb. Another similar make valve set at 200 lb. is placed in the high-pressure cylinder discharge and blows into the high-pressure cylinder suction. A Massachusetts Standard valve, set at 250, discharges to the atmosphere. Later, whatever gas may blow through this valve will be reclaimed.

The ammonia condensers are of the shell-and-tube design and there are eight of them, each of 1073 sq. ft. of tube surface. As seen from Fig. 9 they are vertical, the shells being of 36-in. diameter pipe ⅜ in. thick, welded. The 1½-in. tubes are of piled iron, 12 ft. long, 10 gage, spaced at 2⅛-in. centers, with no lanes between them. Each has one partition giving two passes. Each shell has an expansion ring, electric-welded, and of the same thickness as the shell. The heads are electric-welded. The ammonia-gas connections are 4 in. in diameter and have flanges tool-marked inside the bolt circle, giving the surface sharp V-threads, 24 to the inch. The liquid drains from the bottom of the shells through 1½-in. connections into the liquid headers, of which there are two, one for each four condensers. Equalizing connections are of 1-in. pipe connected in 3 in. below the expansion ring. These connections are tied in with the gas header on the brine coolers so gas may be shut off from any condenser, also



FIGS. 5 AND 6. VIEW OF THE AMMONIA COMPRESSOR FROM THE SYNCHRONOUS MOTOR END, AND, BELOW, SHOWING TWO OF THE THREE BRINE COOLERS IN USE

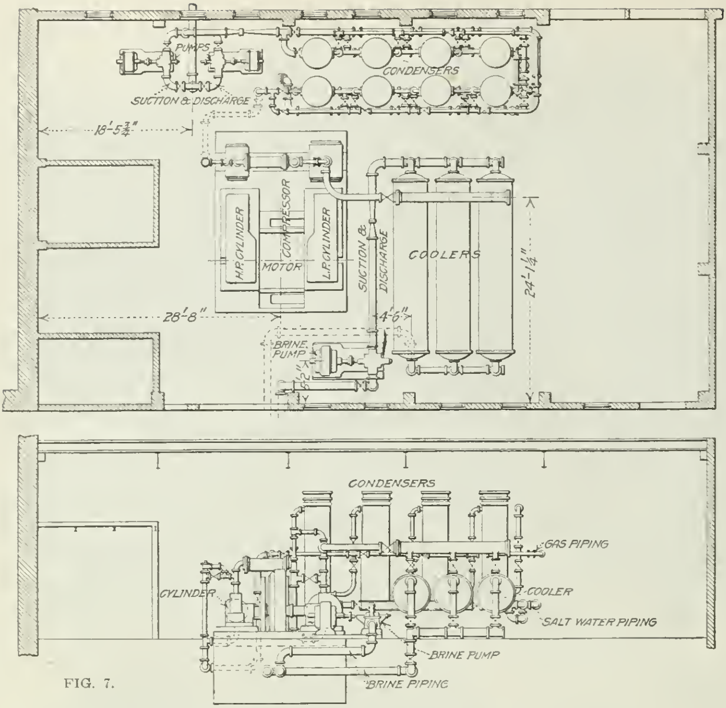
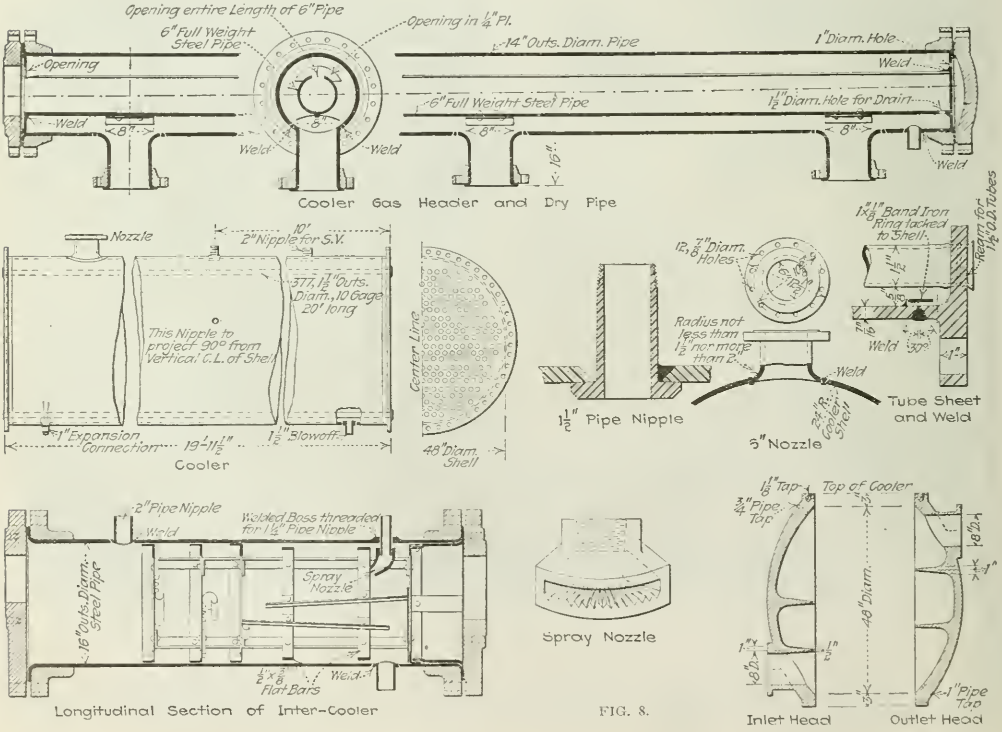


FIG. 7.

FIG. 7. PLAN AND ELEVATION OF EQUIPMENT.

FIG. 8. (TOP) THE GAS HEADER AND DRY PIPE FOR THE BRINE COOLERS. (MIDDLE LEFT) THE BRINE COOLER SHELL AND TUBE SHEET. (MIDDLE RIGHT) DETAILS OF COOLER WELDED CONNECTIONS. (LOWER LEFT) SECTION OF THE LIQUID-GAS INTERCOOLER BETWEEN THE HIGH AND LOW PRESSURE COMPRESSOR CYLINDERS. SPRAY NOZZLE AT LIQUID PIPE INSIDE INTERCOOLER. SECTION OF THE BRINE COOLER HEADS.



Cooler Gas Header and Dry Pipe

Cooler

1½" Pipe Nipple

6" Nozzle

Tube Sheet and Weld

Longitudinal Section of Inter-Cooler

Spray Nozzle

Inlet Head

Outlet Head

FIG. 8.

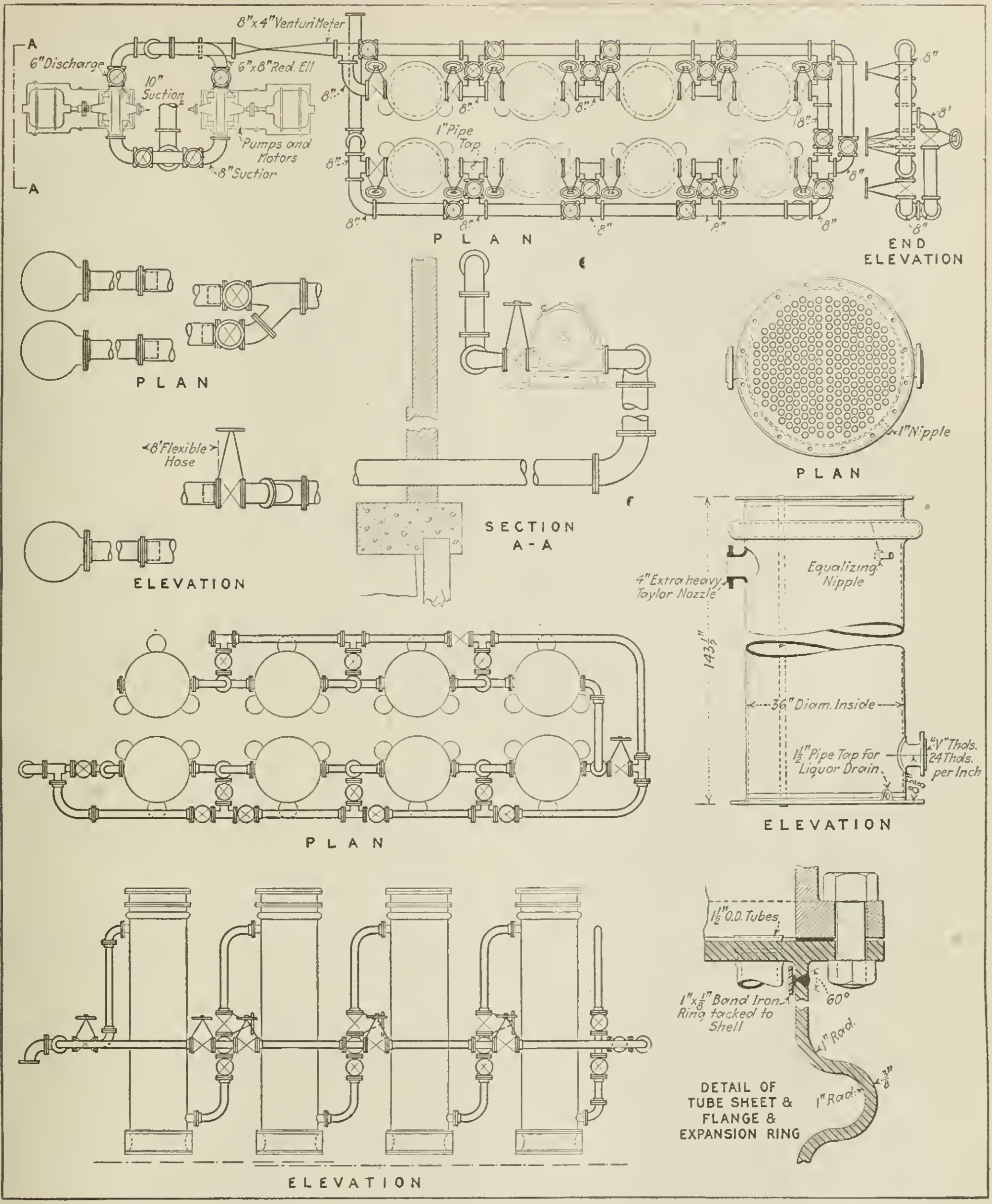


FIG. 9. VARIOUS VIEWS OF CONDENSER CONNECTIONS. THE 8 IN. RUBBER HOSE ON END OF SUCTION PIPE AVOIDS AN EXPENSIVE CRIB.

the water and the liquid evaporated and carried over in to gas header, practically emptying the condenser. It is obvious that should any one or more of the shells "hog" the liquor, it may be conveniently and quickly got rid of by means of the many water and gas connections and valves, which may be manipulated to suit conditions. These condensers may be operated in series or parallel. The ammonia-gas inlet to each shell is 4 in. in diameter, entering the shell at the top through sweeping bends. The gas is directed downward and sweeps at high velocity across the tube bank. Each gas connection is provided with a thermometer well. The cooling velocity will vary between 200 and 300 ft. per minute.

The condensing water is from Boston harbor, circulated by two 6-in. centrifugal volute pumps, each of 1100 gal. per min. capacity, one being sufficient to supply all needed water. The water-ring header around the condensers is 8 in. in diameter. The condensers are counter-current in principle. Each water inlet and outlet to each condenser is provided with a thermometer well; the main outlet and main inlet also have thermometer wells. The circulating water is measured by venturi meter. The practice is to carry about 6 to 8 deg. F. difference in water in and water out of the condensers. During the writer's visit the water in was 55 deg., 63 deg. out. The ammonia liquid was coming out at the same temperature as the water. The chief engineer allows about 2 gallons of cooling water per ton capacity in his condensers, using Boston Harbor water. With condensers free of air, clean and not flooded with liquid, it is expected that there will be realized a pressure in them which is within six to eight pounds of the theoretical.

Substitute for Concrete Crib

The designer has cleverly obviated the use of a concrete crib at the harbor end of the suction pipe. This suction is 10 in. in diameter and at the harbor connects with a 10 × 8 × 8-in. Y. At each 8-in. outlet of the Y is a gate valve, a short nipple on the end of which is fitted with 12 ft. of 8-in. flexible rubber hose. On the end of the hose is a strainer made of 12-in. pipe, slotted to give capacity considerably greater than that of the 10-in. suction. At low tide, or even half tide, each strainer may be hooked to a chain fall, permanently located, lifted, scrubbed and let down again into the water.

The salt-water pumps, besides the usual priming connections, have a priming connection from the top of the pump casing to the top of the valve bonnet on the pump suction.

The horizontal, electric-welded 48-in. diameter 20-ft. long brine coolers, of which there are three, two being in use normally, give remarkable performance. Each has 377 tubes, 1½ in. in diameter, 10 gage, the same as used in the condensers. There are but five passes, the number of tubes in each successive pass being increased and core tubes used to give increased tube surface and increasing velocity to the brine as the temperature head decreases. For example, the first pass has 62 tubes, the last pass 110 tubes with core tubes. The brine comes in at the bottom and out at the top, circulated by an 8-in. centrifugal pump, induction-motor-driven at 1170 r.p.m. Calcium brine of 1.227 to 1.230 sp. gr. is used, 1500 to 2200 gal. being circulated per minute. The temperature difference in and out is usually held at 5 deg. F.; that is, from — 5 deg. in to — 10 deg. out. The velocity through the cooler is about 400 ft. per min. The writer observed the coolers for several days, and at no time excepting once during a slight slop-over was there a perceptible difference between the temperature of the gas at the gas header to the coolers and the brine out; both were —10 deg. all the time, with but two coolers in and the capacity up to full rating. The brine flow is measured by a 10 x 5-in. venturi meter in the pump discharge, between the pump and coolers. In designing allowance was made for a brine flow of 5 gal. per min. with 5 deg. temperature range per ton of 24 hours.

The liquid enters the cooler through a nozzle in the bottom of the shell, projecting it up at an angle about in line with the upper far end of the shell. Each shell has a 2-in. nozzle, welded, for a safety valve. The tubes are fastened in the heads, as shown in Fig. 8. Attention is called to the design of the tube sheet and where it joins the 7/16-in. thick steel shell.

The liquid-level telltale is plainly shown in Fig. 6. Soon feeding of the liquid will be automatic for these coolers. Thermometer wells are liberally provided in the liquid, gas and brine connections.

Practically all ammonia piping is of light weight, no extra-heavy pipe being used. Joints are all flanged, except for small piping when screwed connections are made.

Regulation of capacity to suit the load is had by varying the flow of brine and by shutting down the plant altogether for a period of hours. The latter method is, everything considered, most desirable. One man on a watch easily handles the operation of the plant.

This article would be incomplete without describing one of the provisions in electrically welding the coolers and condensers stipulated by the designer. See Fig. 8. Inside the vessel to be welded and over and ⅛ in. away from the beveled edges of the two parts to be joined, a 1 x ⅛-in. iron band ring is tacked. The gas and slag which ordinarily would get caught at the bottom of the joint are thus free to blow through and allow the bond to become solid. The welds were examined and tested by cutting out samples from three equidistant points around the welded seam. In case of suspicion one or two more might be cut out.

The samples are subjected to physical test and microphotographed. No seams were condemned. After the holes from which the samples were taken were filled by welding, the shells were subjected to working pressure of air (300 lb. for the condensers, 150 lb. for coolers) and the welds painted with soap-and-borax suds. This test completed, the air was let out and a hydrostatic test at 1½ times the working pressure, in accordance with the Massachusetts Rules, was given. The pressure was then dropped to working pressure and the welds were subjected to sharp blows of a 10-lb. hammer.

Steam for heating the plant is taken from the Richmond Street plant a few blocks away; the line carried across Atlantic Ave., thence to T Wharf under water in the harbor. The pressure is 90 lb. at T Wharf. The condensate which forms is collected in the tank on the wall and used for washing or other service to which hot water may be put. One large heating coil is placed under the floor where the operator stands much of the time.

The plant and most of its equipment was designed by Frank L. Fairbanks, chief of the mechanical department of the Quincy Market Cold Storage & Warehouse Co.

The Million-Dollar Brand

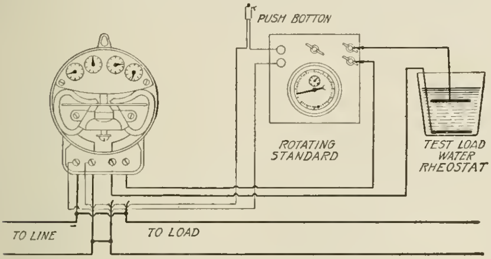
Word comes from Milwaukee of another coal saver known as the Million-Dollar Brand. It is in line with other nostrums of a similar character, but the claims of the inventor, W. Gottschalk, are so amusing from an engineering standpoint that they will bear repetition. In an advertisement appearing in one of the daily papers one gallon of this wonderful material mixed with two gallons of hot water will make "two tons of coal capacity 50 per cent. more heat and reduce the ashes to one-fourth." In other words, it will save 50 per cent. of the coal by making one ton the equivalent of two, thus reducing the cost of coal from $13 per ton to $6.50. With each can of this 50 per cent. coal saver are included "directions for using and sworn testimonials, affidavits and references of well-known citizens and firms of Milwaukee and Chicago, including recommendations of high society women." Fortunately, engineers were omitted from the inventor's collection of references.

Testing Single-Phase Watt-Hour Meter With a Rotating Standard of Different Make

By P. B. FINDLEY

IN AN article, "Testing Single-Phase Watt-Hour Meters With a Rotating Standard," which appeared in *Power*, Feb. 4, 1919, the author described the method of testing a single-phase watt-hour meter in comparison with a standard watt-hour meter or "rotating standard." Such standard instruments are a part of the regular "line" put out by their makers and have in general the same constants as the commercial instruments. That is, at full rated load they run the same speed as do similarly rated commercial instruments. When two such instruments are connected to the same load, it is obvious that if the test meter is 100 per cent. accurate it will make just the same number of revolutions as the standard in any given period. The formula for the per cent. error, if any, is the simple one, $E = \left(\frac{N}{M} - 1\right) 100$, where E equals the error in per cent., N the revolutions of the service meter and M the revolutions of standard meter.

In general, each manufacturer designs its meters to run at the same full-load speed, regardless of the rating. This uniform full-load speed is different for the different makes and types of meters, hence a tester who must make one rotating standard meter serve for all sorts of service meters is sure to find one or more meters for which the foregoing simple formula will not hold. Suppose the standard meter is a Westinghouse instrument and it is necessary to test a General Electric type I, 5-ampere, 100-volt meter. Using the proper range of the standard, that is, 5 amperes, 100 volts, and loading it to 500 watts, it will run at 25 r.p.m. However, when the service instrument is metering 500 watts, it will run at 27.78 r.p.m., if it is 100 per cent. accurate. In other words, when the two meters are connected to the same load, as in the figure, we must adjust the service meter so that it makes exactly 27.78 revolutions while the standard is making 25. The speed at which the service meter operates can be obtained from the formula, $S = \frac{WT}{K \times 3600}$ where S is the revolutions per minute of the service meter; W the full-load watts, in this case 500; T the time in seconds, 60; and K a constant, for the meter in question $K = 0.3$. Then $S = \frac{500 \times 60}{0.3 \times 3600} = 27.78$ revolutions per minute. Since, however, a fractional number of revolutions of a service-meter disk cannot be read accurately, an integral number is chosen, such as 30, and find the proportionally greater number of revolutions of the standard, which may be obtained from the formula, $N_R = \frac{S_R N_S}{S_S}$, where N_R is the number of revolutions of the standard meter corresponding to the chosen integral number of revolutions, N_S, for the service meter; in this case N_S is made 30; S_R the full-load speed per minute of the rotating standard, being 25 for the meter in question; and S_S the full-load speed per minute of the service meter, in this problem 27.78. Then $N_R = \frac{25 \times 30}{27.78} = 27$ revolutions. In actual testing the number of revolutions N_R of the standard is found, while the service meter disk revolves 30 times and if this (N_S) is 27, the accuracy is 100 per cent.



CONNECTIONS FOR TESTING SINGLE-PHASE METER WITH ROTATING STANDARD

In order to facilitate testing, makers of standard meters furnish tables which give, for each make of service meter usually met, the number of revolutions of the standard meter for various percentages of accuracy. Such a table for three different makes of service meters is reproduced herewith. Counting from the left, columns 1 and 2 give the make and rating of the service meter, columns 3 and 4 give the number of revolutions to be observed at full and light loads respectively. Column 5 gives the current range of the standard meter to be used. The next group of columns gives the number of revolutions of the standard which will occur while the service meter is making the number of revolutions given in column 3 or 4, assuming various percentages of accuracy.

Returning to our example of the G. E. type I, 5-ampere, 100-volt meter, use the line across the table indicated by the dagger. As shown above, if 30 revolutions of the service meter are observed, we would find that with 100 per cent. accuracy the standard meter made 27 revolutions in the same time. If, however, the standard made but 26.21 revolutions, the accuracy, or, better named, the per cent. registration, would be 103 per cent.; that is, the service meter would be 3 per cent. fast. If the figure were 26.08, the service meter would be about 3.5 per cent. fast, and so on. It is thus a simple matter to glance at the table and determine roughly the error that has to be adjusted for after each observation.

The tester who wants to master the profession is going to ask next, "How is that table constructed?" The best way to answer this is to start with the assumption that we have no table at all, an actual condition sometimes met. First of all, the fundamental constant of a watt-hour meter *is the watt-hours measured for one revolution of the disk*, and is represented by K. This constant depends of course on the construction and adjustment of the metering element, and the various gears of the register are designed from it to translate revolutions of the shaft into watt-hours upon the dials. In the last group of columns at the right of the table are given the values of K, the values in columns headed "Service" being for the meters listed in columns 1 and 2. The constant for any particular meter can be found marked somewhere on it—on the inside of the terminal box cover, on the disk or on the dial-plate.

To compare two meters we use the formula:

$$Per\ cent.\ registration = \frac{N_S\ K_S}{N_R\ K_R} \times 100$$

where N_S = observed revolutions of service meter;
N_R = observed revolutions of standard meter;
K_S = watt-hour constant of service meter;
K_R = watt-hour constant of standard meter.

If two similar meters are being compared, we have $K_S = K_R$ and the per cent. registration is $\frac{N_S}{N_R} \times 100$, which is the same as the formula mentioned at the beginning of this article.

Returning again to the case of the G. E. type I meter, we find that its constant is 0.300; and that of the Westinghouse standard is 0.333. Substituting these values in the formula, and assuming that we have found that 27 revolutions of the standard (N_R) correspond to 30 of the service meter (N_S) we have:

$$Per\ cent.\ registration = \frac{30 \times 0.300}{27 \times 0.333} \times 100 = 100\ per\ cent.$$

therefore, the service meter is in perfect adjustment. If, however, we had read 28 revolutions of the standard, then the percentage registration would be $\frac{30 \times 0.300}{28 \times 0.333} \times 100 = 96.4$ or 3.6 per cent. slow.

It is now a simple matter to construct the table. Letting P equal per cent. registration, and solving for N_R we have $N_R = \frac{N_S K_S}{P K_R} \times 100$. Using the values of the illustration $N_R = \frac{30 \times 0.300}{P \times 0.333} \times 100$. Then substituting various values of P from 94 to 106, we will get the figures in the table for that particular case and by using proper values for N_S, K_S and K_R, we can construct the entire table.

In the practical use of the table it is worth remembering that the figures for the values of N_R increase above the rotating standard's 100 per cent. value, if the service meter is "slow," and decrease if the service meter is "fast," and that the change is about 1 per cent. of the "standard" value for each 1 per cent. change in registration of the service meter. If the accuracy of the service meter, after adjustment, must be within, say, 2 per cent. fast or slow, the simplest way is to make up a table giving only the service-meter ratings, the number of revolutions to be observed and the revolutions of the standard meter given in the "98 per cent." and "102 per cent." columns. The service meter is then adjusted till the reading of the standard falls within these limits. It is better as a rule to record at each test the actual accuracy of the service meter, in which case the complete table is necessary.

Tables similar to that used in this article are furnished on request by the manufacturers of standard watt-hour meters.

DATA FOR TESTING 60-CYCLE SINGLE-PHASE WATT-HOUR METERS WITH SINGLE-PHASE PORTABLE STANDARD

	Service Meter			Portable Standard Meter														Watt-Hours per Rev.			
		Revolutions			Revolutions of Standard for 94 per Cent. to 106 per Cent. Registration of Service Meter													100-110 Volt Meters		200-220 Volt Meters	
Make	Ampere Capacity	Heavy Load	Light Load	Ampere Capacity	94 per Cent.	95 per Cent.	96 per Cent.	97 per Cent.	98 per Cent.	99 per Cent.	100 per Cent.	101 per Cent.	102 per Cent.	103 per Cent.	104 per Cent.	105 per Cent.	106 per Cent.	Service	Standard	Service	Standard
Westinghouse Types B and C	5	25		5	26.60	26.32	26.04	25.77	25.51	25.25	25.00	24.75	24.51	24.27	24.04	23.81	23.58	0.333	0.333	0.666	0.666
	10	25		10														0.666	0.666	1.333	1.333
	20	25	..	20														1.333	1.333	2.666	2.666
	40	25	...	40														2.666	2.666	5.333	5.333
	5		1.0	5	1.06	1.05	1.04	1.03	1.02	1.01	1.00	0.99	0.98	0.97	0.96	0.95	0.94	0.333	0.333	0.666	0.666
	10		1.0	10														0.666	0.666	1.333	1.333
	20	.	1.0	20														1.333	1.333	2.666	2.666
	40	.	1.0	40														2.666	2.666	5.333	5.333
	15	20		10	31.91	31.58	31.25	30.93	30.61	30.30	30.00	29.70	29.41	29.13	28.85	28.57	28.30	1.00	0.666	2.00	1.333
	30	20	.	20														2.00	1.333	4.00	2.666
	60	20		40														4.00	2.666	8.00	5.333
	15	.	1	10	1.60	1.58	1.56	1.55	1.53	1.52	1.50	1.49	1.47	1.46	1.44	1.43	1.42	1.00	0.666	2.00	1.333
	30		1	20														2.00	1.333	4.00	2.666
	60	.	1	40														4.00	2.666	8.00	5.333
	80	15	.	40	31.91	31.58	31.25	30.93	30.61	30.30	30.00	29.70	29.41	29.13	28.85	28.57	28.30	5.333	2.666	10.666	5.333
	80	..	1	40	2.13	2.11	2.08	2.06	2.04	2.02	2.00	1.98	1.96	1.94	1.92	1.90	1.89				
General Electric Type I	3	30	.	5	19.15	18.95	18.75	18.56	18.37	18.18	18.00	17.82	17.65	17.48	17.31	17.14	16.98	0.200	0.333	0.400	0.666
	3	..	2	5	1.28	1.26	1.25	1.24	1.22	1.21	1.20	1.19	1.18	1.17	1.15	1.14	1.13				
	5†	30		5	28.72	28.42	28.12	27.83	27.55	27.27	27.00	26.73	26.47	26.21	25.96	25.71	25.47	0.300	0.333	0.600	0.666
	10	30	.	10														0.600	0.666	......	...
	5	.	2	5	1.91	1.89	1.88	1.86	1.84	1.82	1.80	1.78	1.76	1.75	1.73	1.71	1.70	0.300	0.333	0.600	0.666
	10	.	2	10														0.600	0.666	......	....
	200 10*	32		10	31.91	31.58	31.25	30.93	30.61	30.30	30.00	27.70	29.41	29.13	28.85	28.57	28.30	.....	.....	1.25	1.333
	10	..	2	10	1.99	1.97	1.95	1.93	1.91	1.89	1.88	1.86	1.84	1.82	1.80	1.78	1.77	..	....		
	15	30	...	20	23.94	23.69	23.44	23.20	22.96	22.73	22.50	22.28	22.06	21.84	21.63	21.43	21.23	1.00	1.333	2.00	2.666
	15	..	2	20	1.60	1.58	1.56	1.55	1.53	1.52	1.50	1.49	1.47	1.46	1.44	1.43	1.42				
	25	30	..	20	35.90	35.53	35.15	34.79	34.44	34.09	33.75	33.42	33.09	32.77	32.45	32.14	31.84	1.50	1.333	3.00	2.666
	50	30	.	40														3.00	2.666	6.00	5.333
	25	..	2	20	2.39	2.37	2.34	2.32	2.30	2.27	2.25	2.23	2.21	2.18	2.16	2.14	2.12	1.50	1.333	3.00	2.666
	50	..	2	40														3.00	2.666	6.00	5.333
Fort Wayne Type K	5	30		5														0.25	0.333	0.50	0.666
	10	30	...	10														0.50	0.666	1.00	1.333
	..	..		.	23.94	23.68	23.44	23.20	22.90	22.73	22.50	22.28	22.06	21.84	21.63	21.43	21.23	.....	.....	......	...
	5	..	2	5														0.25	0.333	0.50	0.666
	10	.	2	10														0.50	0.666	1.00	1.333
	..	..	.	.	1.60	1.58	1.56	1.55	1.53	1.52	1.50	1.49	1.47	1.46	1.44	1.43	1.42	....	.....	......	...

Load service meter to give revolutions stated in table in about one minute's time.

* Speeds for 200-220-volt meters are same as for 100-110-volt when the 200-volt coil of standard is used, except in the case of 10-ampere type I meters.

† Example referred to in text

Westinghouse Type A and Round Type meters make 50 revolutions per minute at full load; therefore, the revolutions of service meter should be taken as double that given in tabla for types B and C.

Repairing Drumshaft Bearing on Elevator Machine

By D. Alfred Manson

On a large freight elevator so arranged that the cable drum may be driven from the wormshaft or by the back gears, which reduces the speed in the ratio of about one to four and increases the load-carrying capacity to the limit of safety of the cables, trouble was experienced with the drumshaft bearings. By referring to Fig. 1 it will be seen that the bolts of the mainshaft coupling at *B* are used for direct drive, while those of the pinion *A* are removed and the pinion is secured out of mesh by a collar. For slow speed the pinion is bolted to the flange on the back-gear shaft and coupling bolts *B* are removed. In this last arrangement the drum is free to turn upon its shaft, turning in the same direction but at a slower speed than its supporting shaft.

This slow motion is intended for occasional use only, but on account of the expected arrival from day to day of some heavy machinery at our plant, it was allowed to remain in slow gear for over a week. The bearings supporting the drum upon its shaft were provided with compression grease cups and they were well filled with grease. The cups did not work, however, probably due to too hard grease or an accumulation of dirt in the passages. As a result the bearing of the drum, which was of cast iron, became badly worn. The shaft is 6 in. in diameter and the drum's bearing cut itself to about 7 in. diameter before attention was drawn to it by the peculiar rumbling sound.

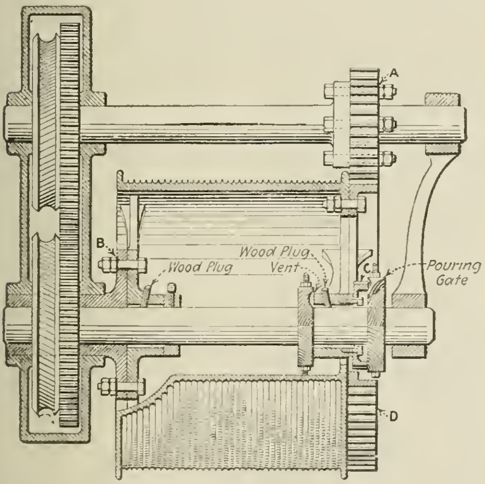


FIG. 1. SECTION THROUGH ELEVATOR DRUM AND CRANES

This is a very busy machine and is kept in use for twenty-four hours daily, so it was decided to make a temporary repair until such time as the rush was over, when the shaft could be renewed as well as bronze bushings fitted into the drum. The emergency repair was made as follows:

First, all strain of the cables had to be removed from the drum. This was done by suspending the car with heavy ropes from the overhead framework, while the counterweight was raised by jackscrew placed in the pit. The gearing was put back to high speed, which centered that end of the drum about the shaft with its own coupling bolts, as at *B*. The other end was now in the air with no assurance that it was concentric with the shaft. It was assumed that the bearing had cut itself large by an equal amount all the way around. This was measured and it averaged about one-half inch radially.

Four pieces of cast iron ½-in. square and of the length of the drum bearing were cut halfway through at three points, as in Fig. 2, and then pushed in equidistant around the opening between shaft and bearing. A piece of hard wrapping paper was put around the shaft before the iron spacers were put in. This served the purpose of keeping the babbitt from adhering to the irregularities on the shaft and gave clearance for grease.

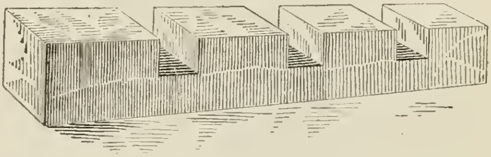


FIG. 2. SHAPE OF CAST-IRON PIECES PLACED IN DRUM-SHAFT BEARINGS

There is a gear *C* bolted to the end of the drum bearing, its purpose being to operate the limits. The bore of this gear was cut large by the same amount as the drum bearing, and the bolts were bent and otherwise damaged. This gear was centered true with the shaft and secured by new bolts. Two wooden collars, made in two sections, were now fitted around the shaft, one at the inside end of the bearing, the other at the outside of the limit gear. A wooden plug was pushed into the oil hole, now drilled clear, until it came in contact with the paper around the shaft. After providing a vent and a pouring gate in the wood collars, the collars were luted with asbestos mixed with oil instead of water, to prevent a blow. The babbitt was poured a little hotter than usual practice, and this proved a success. The other bearing was much easier, as there was no gear and it was already centered and held by the coupling bolts.

The paper that had been placed about the shaft was left inside the babbitt, but caused no trouble before it was broken up and forced out in operation. It was hoped this repair would last for at least three months. As a matter of fact, it was two years and six months before the babbitt began to crack and necessitate the permanent repairs. The job was completed in nine hours by a mechanic and two helpers.

Where an electric power company was sued for loss of a telephone exchange by fire, alleged to have been started through negligence of the power company in permitting a current of electricity on its wire to come in contact with plaintiff's telephone wire and be transmitted into the building and switchboard, plaintiff was entitled to recover on a theory either that a negligent overcharge of defendant's wire or failure to use proper means or appliances to avoid contact between the wires was the cause of the fire. (Alabama Supreme Court, Davidson vs. Alabama Power Co., 82 Southern Reporter, 91.)

The Salaries of Operating Engineers

FROM a number of letters received by *Power* there seems to be a feeling among engineers that their wages are not up to the level of those of other occupations requiring the same amount of skill and responsibility. In order to arrive at the truth of the matter, *Power* sent a questionnaire to a number of operating engineers throughout the country, asking for information as to hours, wages and type and size of plant. The replies to these letters have been classified and the information is now presented, together with data gathered from other sources.

TABLE I. SALARIES IN CENTRAL STATIONS*

Locality	Capacity in Kw. Basis	Source of Power	Method of Firing	Ch. Engr.		Watch Engrs.		Oilers		Firemen		Ch. Electricians		Electricians		Switchboard Operators		Pipe Fitters		Laborers	
				Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.
Maine	24,000	Water	......	..	208	8	108	8	104	..	...	8	114	8	104	8	127	8	104	8	89
Vermont	7,500	Steam Water and Purchased	......	..	140	9	112	..	...	9	104	9	120	9	100	9	96	..	...	9	88
New York state	2,000	Steam	Hand	8	150	8	120	..	...	8	115	..	150	8	85	..	...	..	...	..	...
New York state	670	Steam	Hand	8	152	8	105	8	104	..	...	..	...	..	...	..	...	..	...	..	...
Washington, D. C.	1,000	Steam	Hand	12	150	12	105	..	...	12	98	..	...	..	...	..	...	..	...	..	...
Virginia	5,250	Steam	Stoker	8	175	8	155	..	...	8	105	..	...	9	170	..	...	..	...	9	136
West Virginia	15,000	Steam	Stoker	..	275	8	173	8	154	8	142	..	...	..	...	8	132	9	228	9	120
Ohio	35,000	Steam	Stoker	8	250	8	175	8	156	8	156	8	225	8	154	8	135	8	134	8	104
Ohio	1,200	Steam	Hand	..	175	..	145	..	...	..	130	..	...	..	...	..	...	..	...	..	...
Ohio	9,250	Steam	Stoker	12	200	12	200	12	164	12	173	..	...	..	...	..	...	..	...	..	...
Missouri	425	Steam	Hand	8	160	8	122	..	...	8	108	..	...	..	...	..	...	..	...	..	...
Colorado	30,000	Steam	Stoker	..	185	8	135	..	...	8	130	8	145	8	118	8	112	8	140	..	...
Oklahoma	6,000	Steam and Gas	Oil and Gas	..	300	12	180	12	150	12	180	8	175	8	145	..	...	10	165	10	110
New Mexico	1,725	Steam	Hand	12	175	8	115	..	...	8	105	..	...	..	...	..	...	8	90	..	...
San Diego, Cal.	11,250	Steam	Oil	8	225	8	140	8	115	8	120	..	...	8	180	8	120	8	120	8	93

*Salaries on basis of dollars per month.

Tables I to V give the information from the questionnaires, classified by type of plant, as follows: (1) Central stations; (2) railway plants; (3) hotels, apartments and public buildings; (4) office buildings; (5) industrial plants. Each table has been arranged geographically, beginning with the northeastern part of the country and working westward and southward to California. Capacities of plants were given, some in kilowatts and some in horsepower. For uniformity, these are all given in the tables on a basis of kilowatts, although some of the plants do not generate electric power. The hours given are hours' work per day. Although wages are paid on every basis from hourly to yearly, the table shows the equivalent monthly rate for all cases.

TABLE II. SALARIES IN RAILWAY PLANTS

Locality	Capacity in Kw. Basis	Source of Power	Method of Firing	Ch. Engr.		Watch Engrs.		Oilers		Firemen		Ch. Electricians		Electricians		Switchboard Operators		Pipe Fitters		Laborers	
				Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.
Vic. of N.Y. City	175,000	Steam	Stoker	8	300	8	250	8	142	8	155	8	300	..	...	..	...	8	160	8	132
New York state	1,790	Steam	Stoker	8	240	12	190	8	114	8	116	..	...	..	...	..	...	..	...	8	116
New York state	2,000	Steam	Hand	8	150	8	120	..	...	8	115	..	150	8	85	..	...	..	...	..	...
Alabama	1,350	Steam	Hand and Stoker	10	242	8	160	8	90	8	95	..	220	..	...	..	...	..	...	8	105
Middle West city	12,000	Steam and Purchased	Stoker	12	250	12	190	8	104	8	104	..	...	..	...	8	116	8	125	8	90
Not stated	1,350	Steam	Hand	..	230	8	163	8	90	8	90	..	...	..	...	..	...	..	...	..	...

TABLE III. SALARIES IN HOTELS, APARTMENTS AND PUBLIC BUILDINGS

Locality	Capacity in Kw. Basis	Source of Power	Method of Firing	Ch. Engr.		Watch Engrs.		Oilers		Firemen		Ch. Electrician		Electricians		Pipe Fitters		Laborers	
				Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.
Central Massachusetts	400	Steam	Hand	8	180	8	120	..	...	8	104	..	...	8	140	..	...	..	...
New York state	746	Steam	Stoker	8	145	8	93	..	...	8	85	..	...	..	...	..	...	..	...
New York state	112	Steam and Purchased	Hand	..	...	8	125	..	...	‡8	100	..	...	..	...	..	...	..	...
Washington, D. C.	525	Steam	Stoker	8	170	8	120	8	90	8	95	8	135	8	120	8	110	8	80
Washington, D. C.	350	Steam	Stoker	8	208	8	150	..	...	8	100	..	...	..	...	..	...	..	...
Washington, D. C.	150	Steam	Hand	12	145	12	110	..	...	12	65	..	...	..	...	..	...	..	...
Ohio	225	Purchased	Hand	8	120	..	...	..	...	8	90	..	...	..	...	..	...	..	...
Ohio	525	Steam	Stoker	8	164	8	151	9	140	8	120	8	163	..	...	9	140	..	...
Mississippi	465	Steam	Hand	12	*125	12	†85	..	...	8	†50	..	...	..	...	10	†80	10	†60
Chicago, Ill.	...	Steam	Hand	12	150	10	90	..	...	10	85	..	...	10	125	10	125	10	75
Denver, Colo.	375	Purchased	Hand	12	190	8	110	..	...	9	75	..	...	..	...	..	...	..	...
Seattle, Wash.	150	Steam	Oil Burners	8	†175	8	†100	..	...	..	...	..	...	..	...	..	...	..	...
Portland, Ore.	110	Steam	Oil Burners	9	† 90	9	† 75	..	...	9	†70	..	...	..	...	..	...	..	...
San Francisco, Cal.	500	Steam	Oil Burners	8	225	8	175	..	...	8	140	..	...	8	175	..	...	..	...

*Including house. †Including board. ‡Third class engineer at night.

Table VI gives a summary of salary data for chief engineers and watch engineers, collected from New York City, independently of the questionnaire referred to. Table VII gives similar data from New Jersey near New York City, Table VIII from Chicago, and Table IX from St. Paul, Minn. In a number of cases the original data at hand showed wages per hour, but omitted the hours per day or days per week. In these cases the monthly rate was not computed, but the rate per hour is given.

The city hall plant in a large Eastern city employs one chief engineer at $2,000 per year, three assistant engineers at $4.75 per day, three operating engineers at $4.25, five pumpmen and three dynamo men at $3.50, and twenty firemen at $4 per day. All engineers and pumpmen carry engineers' licenses, and all employees work eight hours per day. In the same city, in an industrial plant, the following amounts are paid: Chief engineer, $195; watch engineer, $173; firemen, $138.50 per month. In this case watch engineers work twelve hours and firemen eight hours per day. Another industrial plant in the same city pays watch engineers 45c per hour and firemen 47c per hour, both working twelve hours per day. Engineers and firemen in another Eastern city in hospitals receive $5 per day. At Niagara Falls firemen are being paid 78c per hour. According to a table prepared by the Bureau of Labor Statistics of the United States Department of Labor, engineers receive $139.34 and firemen $120.52 per month in the bituminous-coal fields.

TABLE IV. SALARIES IN OFFICE BUILDINGS

Locality	Capacity in Kw. Basis	Source of Power	Method of Firing	Ch. Engr.		Watch Engrs.		Oilers		Firemen		Ch. Electricians		Electricians		Pipe Fitters		Laborers	
				Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.
New York City	1,200	Steam	Stoker	8	165	8	135	8	90	8	98	8	175	8	91	8	135	8	87
New York City	225	Steam	Stoker	..	240	..	120	..	...	..	100	..	...	..	120	..	...	..	...
New York City	750	Steam	Stoker	..	...	8	180	..	...	8	143	..	...	..	...	..	...	..	...
Philadelphia, Penn.	1,860	Steam	Hand	9	...	9	110	10	90	9	95	..	...	..	...	..	...	..	...
Pittsburgh, Penn.	1,200	Purchased	.....	..	225	8	162	8	140	..	...	8	200	8	216	8	235	8	105
Pittsburgh, Penn.	375	Steam	Stoker	8	135	8	125	9	90	..	...	8	135	..	...	..	...	..	...
Pittsburgh, Penn.	188	Steam	Stoker	8	200	8	132	..	...	8	98	..	...	..	...	..	...	8	90
Missouri	75	Purchased	Hand	12	145	..	...	..	...	10	*75	..	...	..	...	..	...	..	...
Detroit, Mich.	1,000	Steam	Stoker	..	275	8	130	..	...	8	105	10	155	10	130	..	...	..	...
Portland, Ore.	...	Purchased	.....	..	175	8	95	..	...	..	...	..	...	..	...	..	...	..	...
San Francisco, Cal.	...	Purchased	.....	9	150	9	100	..	...	..	...	..	...	..	..	..	...	..	...

*Only during heating season.

The recent union agreement for municipal engineers in Boston was noted in *Power* for Aug. 19, 1919. The weekly salaries given there were as follows: For operating engineers at pumping stations, $37; on city ferries, $42; in public buildings with first-, second- and third-class plants, $37, $33 and $40, respectively, while engineers in charge in first-, second- and third-class plants receive $42, $37 and $33, respectively. Firemen and oilers in all plants receive $5 per day. All men work eight hours per day, six days per week. In non-municipal plants in Boston, the following wages are paid watch engineers: In railway plants, $45; in the army base plants, $45 to $52.50, and in two commercial plants, $40.

TABLE V. SALARIES IN INDUSTRIAL PLANTS

Locality	Capacity in Kw. Basis	Source of Power	Method of Firing	Ch. Engr.		Watch Engrs.		Oilers		Firemen		Ch. Electricians		Electricians		Pipe Fitters		Laborers	
				Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.	Hr.	Sal.
Central Massachusetts	450	Steam	Stoker	..	185	8	140	8	112	..	...	..	...	..	...	..	...	9	74
New York state	225	Steam	Hand	8	165	8	150	..	...	..	...	..	...	..	...	..	...	..	...
New York City	825	Steam	Hand	9	292	10	160	10	104	9	114	9	160	9	96	9	160	..	...
New York City	600	Steam	Hand	8	240	9	140	9	80	9	100	9	200	9	100	9	100	9	75
New York City	450	Steam	Hand	..	221	11	123	..	...	11	90	..	...	..	...	..	...	..	...
Philadelphia	182	Steam	Hand	..	130	9	95	..	...	..	...	..	...	10	65	..	...	..	...
Ohio	790	Steam Water Purchased	Stoker	12	156	12	124	..	...	12	110	..	...	..	...	..	...	..	...
Ohio	1,000	Steam	Stoker	8	212	12	180	..	...	12	180	..	...	..	...	..	...	..	...
Mississippi	470	Steam	Hand	11	225	11	120	11	90	11	90	..	...	..	...	..	...	11	90
St. Louis, Mo.	1,120	Steam	Stoker	..	210	8	156	8	120	8	136	..	...	..	...	..	...	..	...
Texas	56	Steam and Purchased	Hand	11	173	11	108	..	...	11	78	..	...	..	...	..	...	..	...
Chicago, Ill.	12,000	Steam	Stoker	10	325	8	166	8	125	8	135	10	300	8	192	8	156	8	104
Chicago, Ill.	95	Steam	Hand	8	140	..	...	..	...	..	...	..	...	..	...	..	...	..	...
Detroit, Mich.	1,120	Purchased	Stoker	8	225	12	198	..	...	12	180	..	...	..	...	..	...	..	...
Detroit, Mich.	400	Steam	Stoker	9	160	8	120	..	...	8	100	9	160	9	100	..	...	..	...
Minneapolis, Minn.	465	Steam	Stoker	10	160	10	120	..	...	10	114	..	...	..	...	10	144	10	108
Minneapolis, Minn.	800	Steam	Stoker and Hand	9	180	10	100	..	...	10	93	..	...	9	120	9	115	9	85
Seattle, Wash.	625	Steam	Hand	11	182	..	...	8	96	8	96	..	...	..	...	..	...	..	...
Portland, Ore.	95	Steam	Oil	9	163	9	117	..	...	..	...	..	...	..	...	..	...	..	...

TABLE VI. ENGINEERS' SALARIES IN NEW YORK CITY

No.	Kind of Plant	Hours Per Day	Days Per Week	Chief Engineer Basis of Pay	Chief Engineer Pay per Month	Watch Engineers Basis of Pay	Watch Engineers Pay per Month	Union	Remarks
15	Breweries	8	6	Weekly	213 to 425	Weekly	169	Yes	Double time for overtime.
8	Refrigerating plants	8	6	Weekly	248	Weekly	164	Yes	Double time for overtime.
8	Hotels	8	6	....	...	Monthly and Weekly	132	No	
6	Hotels	12	7	....	...	Monthly	115	No	
3	Theaters	8	6	Weekly	228	Weekly	139	Yes	Double time for overtime.
1	Theater	8	7	Weekly	139	Weekly	121	No	
..	Asphalt industry	8	5½	Weekly	213	Weekly	156	Yes	Double time for overtime.
1	Store	8	6	....	...	Weekly	130	No	
1	Club	9	7	....	...	Monthly	120	No	
1	Charitable institution	12	7	....	...	Weekly	108	No	
2	Office buildings	9	6	....	...	Weekly	127	No	
1	Laundry	9	6	....	...	Weekly	173	Yes	

Table X gives data for watch engineers from a number of plants employing union men in one district of New York City. A certain office building in New York City paid $21 per week to watch engineers and $17 to firemen in 1914. Various raises were made until the plant was unionized in the spring of 1915, when the prevailing union scale of $30 and $22 for engineers and firemen, respectively, came into force. Since then two voluntary raises have been granted, bringing the weekly wages to $34 for engineers and $27 for firemen. A new union agreement has recently been signed providing for $42 for engineers and $33 for firemen per week.

A recent union agreement for engineers in the coal industry in Chicago has been signed. Under this the men work eight hours per day with a half holiday on

TABLE VII. ENGINEERS' SALARIES IN NEW JERSEY NEAR NEW YORK CITY

No.	Kind of Plant	Hours Per Day	Days Per Week	Chief Engineer Basis of Pay	Chief Engineer Pay per Month	Watch Engineers Basis of Pay	Watch Engineers Pay per Month	Union	Remarks
14	Breweries	8	6	Weekly	213	Weekly	137	Yes	Time and half for overtime.
7	Ice plants	8	..	....	...	Weekly	156	Yes	Double time for overtime. Salaries quoted are minimums.
..	City and country plants	Not stated		Yearly	208	Yearly	150	Yes	Two weeks' vacation with pay.
..	Several industrial plants	8	5½ & 6	....	...	Daily	143 to 156	Yes	

TABLE VIII. ENGINEERS' SALARIES IN CHICAGO

Kind of Plant	Hours Per Day	Days Per Week	Chief Engineer Basis of Pay	Chief Engineer Pay per Month	Watch Engineers Basis of Pay	Watch Engineers Pay per Month	Union	Remarks
Ice plant	8	..	Monthly	250	Hourly	...	?	80c per hour.
Breweries	8	6	Monthly	275 to 300	Hourly	...	?	89½c per hour.
Wood-working plant	8	6	....	...	Hourly	146	Yes	Five hours' pay for washing boilers on Sunday.
Asphalt plant	8	..	....	...	Hourly	...	?	87c per hour.
Office building	8	7	....	...	Monthly	145	Yes	
Office building	12	7	....	...	Monthly	125	No	
Laundry	9	5½	....	...	Hourly	140 to 172	Yes	
Laundry	12	5½	....	...	Weekly	108	No	
Railway plant	8	..	Monthly	213	Monthly	187	?	
Pumping plant	8	6	Monthly	250	Monthly	205	?	
Hospital	8	..	....	...	Hourly	...	Yes	87½c per hour.
Steel plant	12	7	....	...	Hourly	182	?	

TABLE IX. ENGINEERS' SALARIES IN ST. PAUL, MINNESOTA

Kind of Plant	Hours Per Day	Days Per Week	Chief Engineer Basis of Pay	Chief Engineer Pay per Month	Watch Engineers Basis of Pay	Watch Engineers Pay per Month	Union	Remarks
Packing houses	..	..	....	...	Hourly	...	No	52½c to 62½c per hour.
Breweries	..	..	....	...	Hourly	...	Yes	65c per hour.
City plants	..	..	....	...	Hourly	...	...	Union Scale 70c per hour.
Cold storage plant	8	..	....	...	Hourly	...	Yes	70c per hour.
Cold storage plant	9 to 10	..	....	...	Monthly	175	Yes	
Store	..	..	Yearly	250	Hourly	...	Yes	75c per hour.
Store	..	..	....	...	Hourly	...	Yes	70c per hour.
Small industrial plant	9 to 10½	..	....	...	Monthly	110	No	
Railway shop	8	..	Monthly	115 to 151	Hourly and Monthly	93 to 110	No	

Saturday. Watch engineers receive $38 a week for day shifts, and $40 for night shifts. Sundays and holidays they receive $12 for the day shift and $14 for the night shift. Overtime is paid at $1.25 per hour on weekdays and $2.25 per hour on Sundays and holidays. Hoisting engineers get $35 and trolley engineers $33 per week.

TABLE X. SOME UNION WATCH ENGINEERS' SALARIES IN NEW YORK CITY

Kind of Plant	Hours per Day	Days per Week	Basis of Pay	Pay per Month
Central station	8	7	Weekly	$167
Factory	8	5½	Weekly	156
Factory	8	6	Weekly	176
Factory	8	6	Weekly	182
Factory	8	7	Weekly	167
Factory	8	7	Weekly	182
Factory	12	6	Weekly	146
Factory	12	6	Weekly	156
Office building	8	6	Weekly	173
Hospital	8	7	Weekly	134
Ice companies	8	7	Weekly	152
Lumber	8	5½	Weekly	156
Lumber	8	6	Weekly	156
Railroad, stationary	8	7	Weekly	177
Dry dock	8	6	Weekly	167
City employees	8		$6 per day	
Shipyards			80c per hour	

In Bakersfield, Calif., the union scale provides for eight hours per day with time and one-half for overtime. Operating engineers receive $6 per day in freight yards, canneries, laundries and wineries, $6.50 in distilleries and $8 in schools, hotels, etc. In electric, gas and ice plants chief engineers get $7, watch engineers $6, and apprentices $5 per day, while on dredges, chiefs get $8.66 and watch engineers $7.60. In Oakland, Calif., the union scale gives $7.04 per day in shipyards. In Baltimore, Md., union rate is 75c per hour for six days of eight hours each for operating engineers. Table XI shows the present wage agreement between the shipowners and the Marine Engineers' Union, while Table XII shows the tonnage of the various classes of ships referred to in Table XI.

TABLE XI. WAGE SCALE FOR LICENSED MARINE ENGINEERS

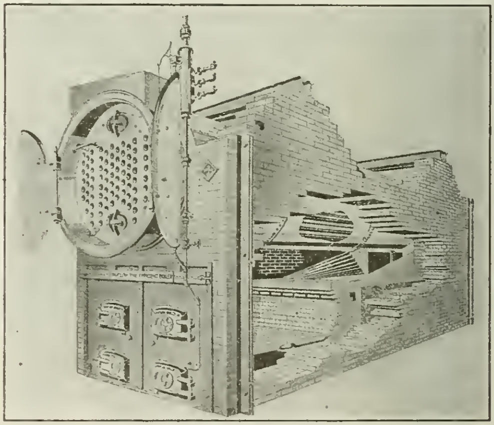
	A	B	C	D	E
Chief engineer	$387.50	$346.25	$332.50	$318.75	$305.00
First assistant engineer	241.25	235.00	228.75	222.50	216.25
Second assistant engineer	212.50	206.25	200.00	193.75	187.50
Third assistant engineer	188.75	182.50	176.25	170.00	163.75
Fourth assistant engineer	165.00	158.75	......	......	......
Junior engineer	135.00	......	......	......	......

TABLE XII. TONNAGE OF SHIPS FOR WAGE CLASSIFICATION

Classes	Single Screws	Twin Screws
A	Over 20,001	Over 15,001
B	12,001 to 20,000	9,001 to 15,000
C	7,501 to 12.000	5,501 to 9,000
D	5,001 to 7,000	3,501 to 5.500
E	Below 5,501	Below 3,501

Uniflow Setting for Boilers

It has been the custom, and is now, to a large extent, for the purchaser of a steam boiler to engage the local brickmason to put up the brickwork and practically to design the furnace. The result of such furnace construction has been that insufficient space has been allowed for combustion to take place, and this has led to uneconomical boiler operation. To overcome this fault, the uniflow furnace and setting have been designed, and complete drawings are furnished with each boiler installation by the Uniflow Boiler Co., Philadelphia, Pa. In this design of furnace setting air is introduced through the bridge-wall in such a way that it is not preheated, and smokeless combustion and secondary ignition of the gases from the fuel result. By the use of an inverted arch extending from the bridge-wall toward the rear of the boiler, the gases are made to impinge against the shell with a scouring action, making that portion of the shell which has previously been insulated with a film of dust a part of the effective heating surface.


PART SECTIONAL VIEW OF SETTING

The brickwork is so assembled as to prevent the internal expansion from disturbing it, and the red brick is retained as the structural element of the setting, leaving the firebrick to function as the heat insulating element alone. With this type of setting the boiler is suspended from I-beams supported on the red brickwork.

Rubber Slugs for Cleaning Condenser Tubes

The number of inquiries *Power* receives and the discussion in its columns about cleaning condenser tubes shows that interest in the subject is keen—and naturally so. It does not take long for condenser tubes to become so heavily coated with scum that the heat transmission through them decreases sufficiently to seriously impair the vacuum. In steam-turbine operation loss of vacuum increases the machine's water rate.

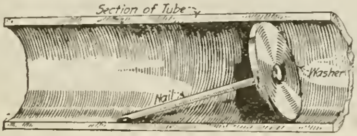


Fig. 1

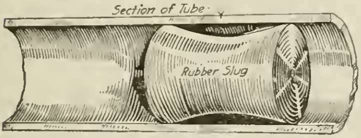


Fig. 2

WASHER AND SLUG FOR CLEANING SLIME FROM CONDENSER TUBES

Several months ago many engineers told how they cleaned condenser tubes. For tubes that scale the most satisfactory practice seems to be the use of a mechanical cleaner similar to those used in cleaning boiler tubes. But for freeing tubes of the scum that collects in them many devices are in use. One that is quite widely applied consists of a leather or rubber washer of diameter to fit the tube and through the center of which a nail is driven. Many of these are made and one placed in each tube when about to clean the condenser. The nail holds the washer almost on edge. Compressed air is used to force the washer through the tube.

The engineers at the Fifty-ninth Street and Seventy-fourth Street Stations of the Interborough Rapid Transit Co., New York City, of which Walter S. Finley is superintendent of motive power, find that the washer does not make contact all around the surface of the tube and therefore does not thoroughly clean off the scum. So they now have in use many hundreds of rubber slugs of the shape shown in Fig. 2. These are placed, one in each tube, and blown through by means of compressed air. The results are highly satisfactory. The slugs are of rubber that is neither very hard nor very soft.

The following description of a device for applying acid to dissolve scale from condenser tubes appeared in a recent issue of *Engineering*, London.

Within recent years the objections which many engineers had to the introduction of chemicals, on account of their fear of corrosion, have been largely overcome, and in quite a number of power plants acid or caustic is now regularly used for cleaning the condensers. In some stations it is still the practice to paint the interior surfaces of the iron casing with acid-resisting enamel before starting cleaning, but this protection is not really needed unless an unnecessarily strong acid is used.

It is obviously desirable to keep the chemical solution in motion while it is attacking the scale in the tubes, and various makeshift devices have been designed and used by engineers for this purpose. A simple arrangement has, however, recently been brought out for the purpose by the Mirrlees-Watson Co., of Glasgow, and is shown in Fig. 3. It takes the form of a steam ejector combined with a circulating pipe and can be fitted on existing handhole doors or to special facings on the end covers of the condenser. The ejector is shown at *A* and is supplied with live steam from any convenient source. The ejector discharges into the lower part of the condenser and is connected on the inlet side with the upper part by means of the external pipe shown.

In operation the condenser is fitted up with clean water and the quantity required for the purpose noted. The two valves *E* and *D* are then opened and steam turned on to the ejector. Water is then sucked through the bell-mouth *G* and discharged through the perforated cone *F*. When circulation is thus established a quantity of the cleaning liquid sufficient to form the required solution is poured into the funnel *B*, and on opening cock *C* this liquid is drawn in and mixed with the hot water circulating in the condenser. The condensation of the steam used in the ejector naturally causes a gradual dilution of the solution, while the chemical reaction neutralizes the acid or alkali, and this has to be counteracted by the addition of more chemical. The ejector must be temporarily shut off if the temperature rises too high.

The nature and quantity of cleaning liquid required and the length of time necessary for the solution to be circulated in the condenser will depend on the character and amount of the deposit. Caustic soda is the best cleanser when the deposit is of a greasy or muddy nature. A 1 per cent. solution—1 lb. of caustic soda to each 100 lb. or 10 gal. of water—should first be used in the condenser, and may be increased gradually to a maximum of 7 per cent. Dilute hydrochloric acid is the most suitable cleanser when the deposit is in the form of a hard scale composed of sulphate or carbonate of lime or magnesia. A 5 per cent. solution may be tried in the condenser at the outset and increased in bad cases to a maximum of 40 per cent., which limit must not be exceeded. In this way a condenser can be cleaned in from six to eight hours unless it has been allowed to get into a very bad condition, and it is only necessary thoroughly to flush it out with a slightly alkaline solution if acid has been used or with water to wash out the remains of caustic, to be able to set the plant to work again. Thus the cleaning can quite conveniently be carried out during the slack time of a week-end.

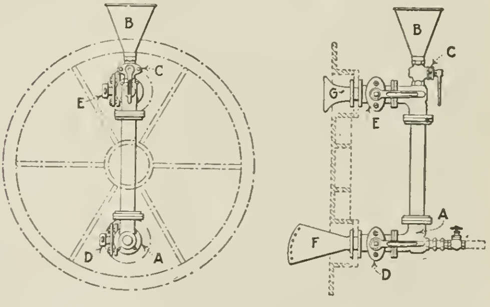


FIG. 3. ARRANGEMENT FOR FEEDING ACID TO CONDENSER TO CLEAN IT OF GREASE AND SCALE

There is only one other means of cleaning condenser tubes, of which we have any knowledge, that has been tried on a practical scale. It is the introduction, temporarily, of sand into the circulating system. Such a scheme has been tried out in South Africa, as mentioned in our "Notes" column recently, and in view of the experience of steamers in the East, just referred to, the idea merits consideration. The disadvantage of the sand method is, of course, that the pump impeller and circulating-valve seatings would be eroded, but if the ejector system could be adopted to handle gritty water and abrasive with a specific gravity approaching unity could be obtained, it appears as if this system of cleaning might appeal to engineers who are still unwilling to use acid for fear of continued corrosion.

The Newport Electric Power Station of the Melbourne Suburban Railway System*

By E. P. Grove

AFTER some years of deliberation the electrification of the entire suburban railway system of Melbourne was decided on and has now been put into operation. The plan adopted provided for the direct-current overhead-wire system. Power in the form of three-phase alternating current at 20,000 volts is transmitted from the general generating station to substations, where it is converted to direct current and delivered to the contact wires over the tracks.

The site of the central power station at Newport was selected principally because of the convenient supply of condensing water. The intake for cooling water is on the west side of the River Jarra retaining wall, while the discharge is turned into a small dock on the east side of the retaining wall and so into the river without mixing with the incoming water.

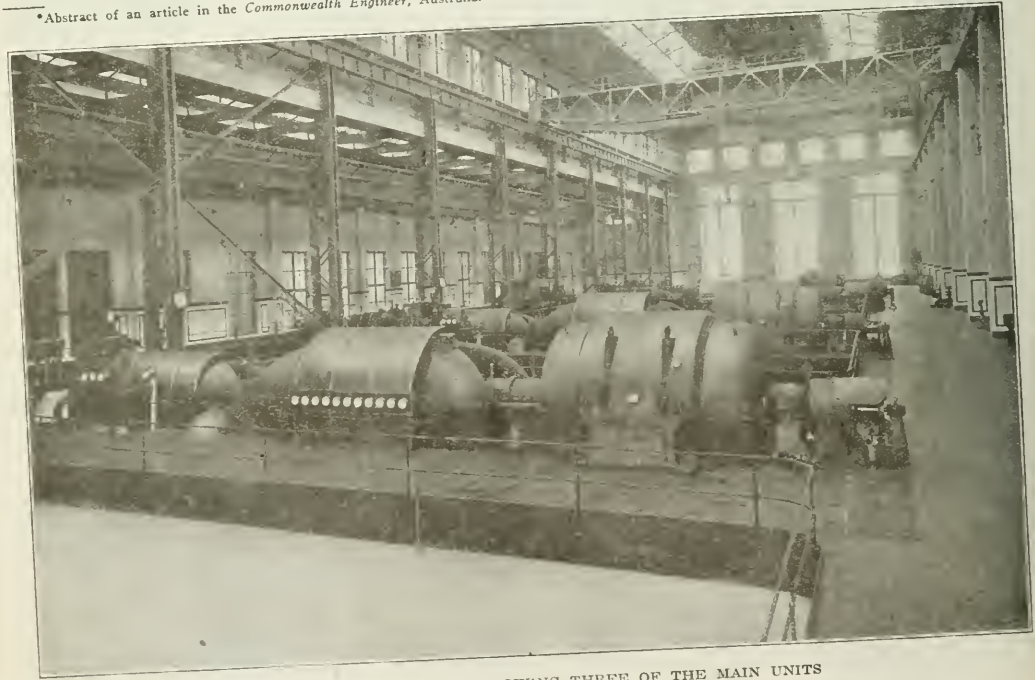
The generators deliver three-phase current at 3300 volts between phases and 25 cycles per second, which is stepped up to 20,000 volts by static transformers for transmission to the substations.

There are six turbo-generator units, each having a normal rated capacity of 10,000 kw. with a maximum continuous output of 12,500 kw. at 0.95 power factor with a maximum temperature rise of 45 deg. C. from an intake air temperature of 25 deg. C. Steam is supplied at 210 lb. per sq. in. pressure and superheated to a total temperature of about 600 deg. F.

The turbine room is 300 x 76 ft. and is joined by the pumphouse, which is 275 x 31 ft. Two boiler houses each 170 x 70 ft. run at right angles to the pumphouse and turbine room, and between the boiler houses are the tankhouse, stores, etc. On the other side of the turbine room is a building containing transformers, batteries, etc., while still farther north of this is the switch-house, control room and administrative offices.

Circulating water is taken in through two canals which lead to the screen pits. Here the first screens are stationary, consisting of bars placed approximately 3¾ in. apart. Beyond these are four revolving screens of the conveyor type, each driven by a 5-hp. induction motor. These screens have a ⅝-in. mesh. There are two motor-driven centrifugal pumps to provide water at 50 or 60 lb. pressure for washing the screens. A 7½-ton crane is provided for lifting the screens for repairs.

There are 12 Babcock & Wilcox marine-type boilers in each house, arranged in two rows of six each with the firing floor between. Each of the 24 boilers has



VIEW OF TURBINE ROOM SHOWING THREE OF THE MAIN UNITS

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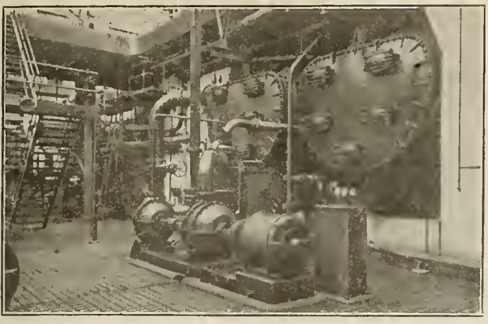
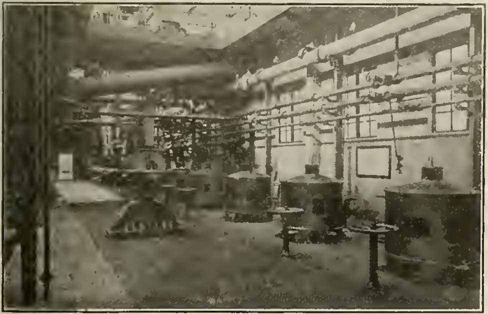
*Abstract of an article in the *Commonwealth Engineer*, Australia.



TWIN CONDENSERS WITH EXTRACTING PUMPS

6725 sq. ft. heating surface and 1043 sq. ft. superheating surface with 168 sq. ft. grate surface. The boilers are in pairs with individual superheaters and economizers, but each pair has a common fan and stack. Under each boiler is an ash bunker having a 12-hour full-load capacity. Below the ash bunkers is a portable crusher which moves on a narrow-gage track. This crusher discharges into a pipe through which the ashes are drawn by air suction to elevated receivers at the end of the boiler houses. Two exhausters for this suction ash-removal system are installed in the basement of each boiler house. The elevated ash receivers discharge by gravity into cars on the track carrying the coal-supply cars.

Coal is brought in hopper-type bottom-dump cars, over a single track from the receiving sidings, to hoppers at the end of the boiler houses. The empty cars continue in the same direction to the departure sidings, thus requiring little or no shunting. From the track hopper the coal drops through a crusher—or if desired around the crusher—to any one of three bucket conveyors as required. Two of these conveyors carry the coal to the bunkers on either side of the boiler house, while the third carries it to a storage yard extending from the end of the boiler house. This same third conveyor returns through a tunnel under the storage ground and is equipped with a traveling filler so that it may be used to reclaim the stored coal. A traveling jib crane rides on the gantry supporting the coal-storage conveyor and may be used to spread storage coal or to help reclaim it. This crane may discharge into an auxiliary hopper over the main-track hopper. Coal from the boiler-house bunkers goes by gravity chutes to the boiler hoppers, which feed the Babcock & Wilcox chain-grate stokers.

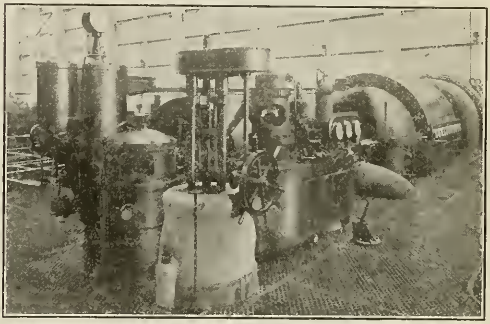


CIRCULATING PUMP MOTORS IN BASEMENT OF PUMP HOUSE

A 10-in. steam header from each row of boilers delivers into a receiver located in the basement of the pumphouse, and from the receivers the steam goes to the turbines. The four receivers are interconnected by a 10-in. main, so that the entire system is very flexible.

The basement of the pumphouse, which is between the engine room and the boiler rooms, contains the feed pumps—two reciprocating and two turbine-driven centrifugal pumps for each boiler house—the high-pressure pumps for fire and for boiler washing, the feed-water heaters and the condenser circulating pumps. The circulating pumps are motor-driven centrifugal pumps with a capacity of 14,000 gal. per min. each at 500 r.p.m. and are located in a pit in the center of the pumphouse so as to be submerged even at low tide. The motors are on the turbine-room basement level. All the circulating pumps deliver into a common 44-in. diameter main which runs the entire length of the turbine-room basement.

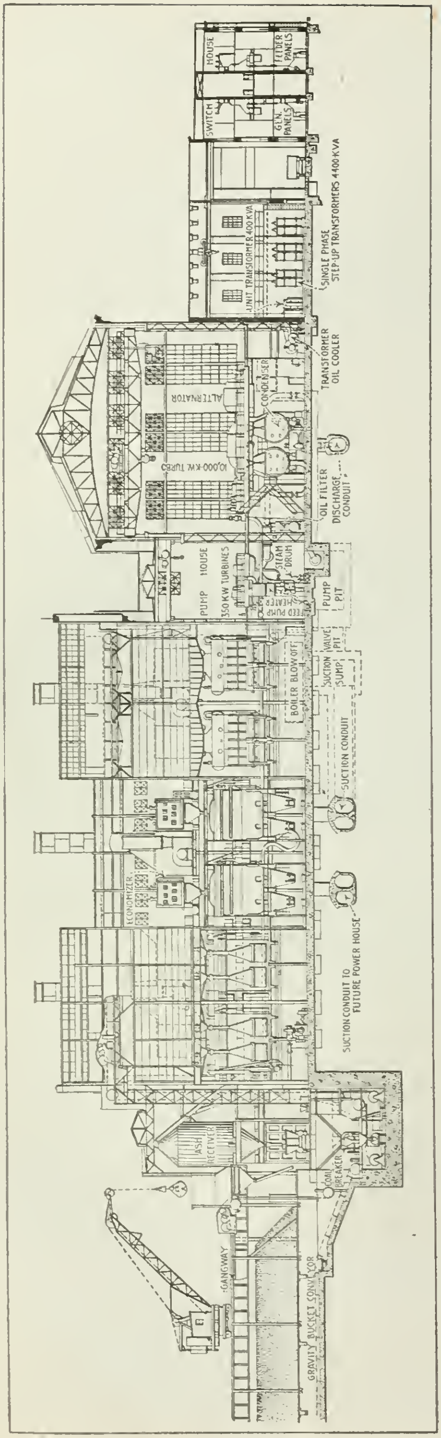
The turbine room contains six 10,000-kw. turbo-generators on foundations carried down to the basement Under each turbine are two twin surface condensers each having 22,000 sq. ft. of tube surface. Alongside the condensers are the kinetic, air and water, extraction pumps. The system is designed to give a 28¾-in. vacuum with a 30-in. barometer, when handling 120,000 lb. of steam per hour. The turbine-room basement also contains the turbine oil coolers, the oil filters, the oil coolers for the step-up transformers, the circulating pumps for the air washers and alternator ventilating fans.



STEAM END OF 10,000 KW. TURBINE

The main turbines are of the Parsons reaction type built by C. A. Parsons & Co., Ltd. The turbine cylinders are divided, the high-pressure cylinder being single flow, while the low-pressure is double flow with center admission. The governing is of the usual Parsons "Gust" type, operated from a cam on the vertical governor spindle. The steam chest is not rigidly connected to the turbine cylinder, thus allowing a much more uniform distribution of metal than in the usual type where the steam chest is mounted on the cylinder. Lubrication is provided by two rotary pumps driven from the governor spindle with a steam-driven auxiliary oil pump for starting and stopping.

The alternator is of Parsons design, giving three-phase current, 3300 volts, 25 cycles per second at 1500 r.p.m. The exciter is of the Parsons four-pole type and is fitted to an extension of the alternator shaft. The ventilation of the alternators is effected by means of fans on the rotor supplemented by motor-driven ventilating fans which draw air through a Sturtevant air washer and deliver it into a chamber in the concrete foundation



LONGITUDINAL SECTION OF BOILER HOUSE AND CROSS SECTION OF PUMP HOUSE, TURBINE ROOM AND TRANSFORMER AND SWITCH HOUSES

of the generator. The air is finally discharged by way of a brick uptake above the transformer chambers.

Two 350-kw. Parsons turbo-generators are installed on the turbine-floor level, in the pumphouse. These auxiliary machines generate three-phase current at 440 volts, 25 cycles, and are used to supply power for the various plant auxiliary motors when the main turbines are shut down. As they are expected to operate only for short periods, they are designed to run non-condensing.

All auxiliary motors in the station take three-phase current at 440 volts. Each main generating unit is equipped with a 400kv.-a. unit transformer fed from the 3300-volt line between the alternator and the step-up transformers, to supply this auxiliary current. In addition there are four 1000-kv.-a. transformers fed from the 20,000-volt busbars for the auxiliary service.

The auxiliary current is distributed from two switchboards, one at each end of the transformer house, in rooms opening onto the turbine floor. In each of these switchboard rooms there is a motor-generator set for charging the lighting and control batteries. These machines consist of a 102-hp. three-phase 440-volt induction motor and a 65-kw. d.c. 110-volt generator.

The auxiliary and step-up transformers for each generator are installed in a separate room in the transformer house. In each room is a traveling crane carriage on which can be hung a 15-ton hoist. This carriage can travel, through openings in the wall, over the railroad track between the transformer house and the switchhouse. These openings are normally closed by sheet-steel doors.

The switchhouse is a brick and concrete building 299 x 44 ft. At one end are offices for the chief engineer and clerical force and at the opposite end is the control room. On the ground floor are the incoming and outgoing cables, potential transformers and isolating switches. On the second floor are the oil switches. The equipment for each generator is in a separate brick chamber, and the oil switches are open to the outside air through vents so as to exhaust any explosive gases. The windows on the oil-switch floor are left unglazed so as to minimize the damage from possible explosions. All oil switches are electrically controlled.

The control room is on the first-floor level with a railed gallery around three sides so that there is no necessity for admitting visitors to the control floor. In the center of the room is the control engineer's desk, which is equipped with telephones to all substations as well as to all parts of the central station. Around the room are the control switchboards, in front of which are the telegraphs by which instructions are sent to the turbine operators and boiler-room attendants. In front of these again are the automatic voltage regulators and loud-speaking telephones for communication to the turbine engineers. On one wall is a complete system diagram arranged for mechanical record of all switching operations.

New Coal Deposit In Chile

An article published recently in the Chilean newspaper, *Las Ultimas Noticias,* gives particulars of several new coal deposits which have been found in southern Chile. The first of these is stated to be near La Union. The quality of the coal is considered to be very good, and machinery is being installed for the exploitation of the deposit. It is estimated that 40,000,000 tons can be extracted, and a special railway is being built to Rapallo station.

Fusibility of Ash From Eastern Coals*

By W. A. SELVIG, O. C. BROWN AND A. C. FIELDNER
Of the Bureau of Mines

THE Eastern coal province, which includes the anthracite regions of Pennsylvania and Rhode Island, the Atlantic Coast region of Virginia and North Carolina, and the great Appalachian region, contains the best-known and most extensively mined coals in the United States.

Previous papers[1] gave a description of the standard gas furnace method used by the Bureau of Mines in making ash-fusibility tests, a discussion of the relation of fusibility tests to clinker formation, and tables giving results obtained for West Virginia, Pennsylvania and Mid-Continent coals. This paper includes a table giving the results obtained for all coals tested from the remaining states of the Eastern coal province and includes coals from Ohio, Eastern Kentucky, Virginia, Maryland, Tennessee and Alabama. No coals from Rhode Island, North Carolina or Georgia are represented. Rhode Island and North Carolina are of little commercial importance as coal producers.

The samples represented are standard mine samples collected by representatives of the Bureau of Mines, the United States Geological Survey, or by the various state geological surveys, according to the methods used by the Bureau of Mines.[2]

The point taken as the softening temperature is that at which the ash, when molded into solid triangular pyramids ¾ in. high and ¼ in. wide at the side of the base and mounted in a vertical position, has fused down to a spherical lump. Samples remaining unfused at 3010 deg. F., which was the highest temperature attained in the test, were marked plus 3010 (+3010), and used as such in figuring the average values for the mine from which the average values of the beds were com-

For convenience in discussion the order of fusibility of coal ash from the various coals of the country may be divided into three groups as follows:

Class 1: Refractory ashes, softening above 2600 deg. F. Class 2: Ashes of medium fusibility softening between 2200 and 2600 deg. F. Class 3: Easily fusible ashes, softening below 2200 deg. F.

The coals of Ohio which were tested gave ash of medium fusibility; the average values of the different beds come mainly in Class 2. The softening temperature of the ash from coals of eastern Kentucky and Virginia cover a wide range of fusibility from readily fusible ashes coming in Class 3, to refractory ashes coming in Class 1. Many of the coal beds of Maryland which are represented give coal having a refractory ash coming in Class 1 or in the upper part of Class 2. The coals tested from Tennessee and Alabama come mainly in Class 2, giving ash of medium fusibility, though both Class 1 and Class 3 are represented.

State, Bed	Number of Mines Sampled	Total Number of Samples	Average Softening Temperature, Deg. F.	Ash in Dry Coal, Average Per Cent.	Sulphur in Dry Coal, Average Per Cent.
Ohio					
Anderson (Bakerstown) Bed	1	1	2120	10.86	3.92
Lower Freeport Bed	8	16	2280	9.55	2.95
Lower Kittanning Bed	4	4	2120	9.24	5.72
Mahoning Bed	1	1	2040	6.59	3.67
Meigs Creek (Sewickley) Bed	5	5	2330	13.02	4.23
Middle Kittanning Bed	6	6	2450	8.00	1.86
Pittsburgh (No. 8) Bed	10	14	2210	8.47	3.58
Uniontown Bed	2	2	2230	16.10	3.58
Upper Freeport (No. 7) Bed	10	14	2280	8.48	3.09
Washington Bed	1	1	2520	21.90	2.98
Waynesburg Bed	4	4	2400	15.92	3.15
Eastern Kentucky					
Alum Bed	1	1	2940	4.37	.61
Elkhorn Bed	8	22	2470	3.83	.68
Fire Clay (Dean, or No. 4) Bed	9	25	+2790	5.35	.82
Flag (No. 7) Bed	1	4	2880	7.52	.88
Harlan Bed	3	8	+2700	3.94	.85
Hazard (Haddix, or No. 6) Bed	1	4	2460	8.56	.79
Hickory Bed	1	4	2340	5.37	1.07
Jellico Bed	1	4	2460	6.92	1.56
Kellioka (C) Bed	1	1	2230	2.21	.49
Lower Bolling Bed	1	1	2880	11.65	1.01
Lower Hignite Bed	1	3	2440	4.57	1.10
Lower Standiford Bed	1	1	2260	5.24	1.81
Mason Bed	3	11	2320	3.93	1.14
Miller Creek (No. 1) Bed	6	13	2160	4.23	1.90
Poplar Lick Bed	1	4	2670	5.30	1.05
Rawl (Gas, or No. 2) Bed	2	2	+2680	7.53	1.90
Straight Creek Bed	4	16	2110	3.40	1.17
Thacker Bed	1	1	2430	4.42	1.39
Upper Hance Bed	1	4	2330	4.74	1.61
Virginia					
"B" Bed	1	1	2420	17.73	2.21
Big Bed	3	3	2420	19.98	.57
Big A No. 2 Bed	1	2	2320	6.34	.60
Big Town Hill Bed	1	2	2240	11.84	.48
"C" Bed	1	2	2210	10.26	1.40
Clintwood Bed	1	1	2670	3.26	.87
Duncan Bed	1	1	2160	6.65	.88
Glamorgan Bed	1	2	2160	5.86	1.22
Imboden Bed	2	3	2420	11.47	1.56
Jawbone Bed	1	1	2240	19.86	1.03
Kennedy (Widow Kennedy) Bed	5	8	2190	7.95	1.09
Large Bed	5	7	+2880	20.19	.62
Little Bed	1	1	+3010	21.29	.49
Little Town Hill Bed	1	2	2440	8.40	.56
Lower Banner Bed	3	8	2280	6.37	.72
Lower Bolling Bed	1	1	2720	8.74	1.12
Meadow Bed	1	2	2480	12.92	.62
Milner Bed	1	1	2120	5.89	1.69
Mohawk Bed	1	2	2160	3.49	1.32
No. 4 Bed	1	3	2180	6.58	.49
Pardee (Parsons) Bed	1	2	2460	8.04	1.59
Pocahontas No. 3 Bed	5	28	2420	4.26	.54
Pocahontas No. 5 Bed	1	1	2090	5.19	.82
Red Ash Bed	1	2	2240	5.96	.64
Small Bed	1	1	+3010	42.98	.34
Splash Dam Bed	1	2	2720	5.77	.65
Upper Bed	2	2	+3010	29.72	.38
Upper Banner Bed	6	20	2420	6.43	.67
Maryland					
Bakerstown Bed	5	5	+2560	10.26	1.70
Bluebaugh Bed	3	3	+2770	12.99	1.63
Brush Creek Bed	1	1	2470	9.61	1.26
Clarion (Parker) Bed	2	2	2280	9.61	2.42
Franklin Bed	1	1	2410	8.48	1.36
Gallitzen Bed	3	3	2140	12.15	3.33
Grantsville Bed	1	1	2490	8.23	1.23
Little Pittsburgh Bed	1	1	+3010	7.95	1.18
Lower Freeport Bed	1	1	2150	20.51	4.11
Lower Kittanning Bed	15	24	2440	10.76	2.26
Mercer (Mt. Savage) Bed	3	3	+2620	18.14	3.28
Pittsburgh (Big) Bed	6	20	+2930	7.67	1.03
Quakertown Bed	1	1	+3010	17.03	2.92
Split-six Bed	1	1	2220	12.42	2.55
Upper Freeport Bed	5	5	2500	10.72	2.03
Upper Kittanning Bed	2	2	+3010	9.50	.86
Upper Sewickley (Tyson) Bed	6	9	+2840	6.65	1.09
Waynesburg Bed	1	1	2410	13.75	2.58
Tennessee					
Angel Bed	1	1	2160	5.80	1.94
Battle Creek Bed	2	3	2520	9.68	1.52
Billygoat Bed	1	1	2600	3.26	1.12
Blue Gem Bed	14	23	2100	3.32	1.34
Bon Air No. 2 Bed	8	21	2180	10.27	3.24
Castle Rock Bed	2	2	2260	10.78	2.68
Catoosa Bed	1	3	2250	7.11	2.59
Coal Creek Bed	22	53	2260	6.30	2.37
Frozen Head Bed	1	1	2580	6.92	.92
Grassy Ridge Bed	1	1	2470	3.75	1.87
Hooper Bed	1	1	2330	2.58	.69
Jellico Bed	14	38	2350	4.95	1.87
Jordan Bed	3	6	2320	3.33	.90

*Published by permission of the Director, U. S. Bureau of Mines.

[1] Selvig, W. A.; Fusibility of Ash from West Virginia Coals," *Power*, Oct. 15, 1918, p. 566-7; *Chemical and Metallurgical Engineering*, Vol. 19, No. 12, 1918, pp. 826-8.

Selvig, W. A., and Fieldner, A. C., "Fusibility of Ash from Pennsylvania Coals," *Power*, June 10, 1919, p. 897; *Chemical and Metallurgical Engineering*, Vol. 20, No. 12, 1919, p. 629.

Selvig, W. A., Ratliff, W. C., and Fieldner, A. C.; "Fusibility of Coal Ash," *Power*, Apr. 1, 1919, p. 479-80; *Chemical and Metallurgical Engineering*, Vol. 20, No. 6, 1919, pp. 274-6.

For complete tables giving results obtained for each mine tested see: Selvig, W. A., "Fusibility of West Virginia Coal Ash," *Coal Age*, Vol. 15, No. 1, 1919, pp. 12-16; Selvig, W. A., and Fieldner, A. C., "Fusibility of Ash from Pennsylvania Coals," *Coal Age*, Vol. 15, No. 24, 1919, pp. 1086-9; Selvig, W. A., Ratliff, W. C., and Fieldner, A. C., "Fusibility of Ash from Coals Found in the Interior Province," *Coal Age*, Vol. 15, No. 16, 1919, pp. 698-703.

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[2] Holmes, J. A.; "The Sampling of Coal in the Mine," Technical Paper 1, Bureau of Mines, 1911, 18 pp.

State, Bed	Number of Mines Sampled	Total Number of Samples	Average Softening Temperature, Deg. F.	Ash in Dry Coal, Average Per Cent.	Sulphur in Dry Coal, Average Per Cent.
Kelley Bed	2	2	2530	7.63	1.33
Lower Dean Bed	1	1	2340	3.69	.72
Mingo Bed	6	19	2390	4.25	1.27
Monarch Bed	1	4	2320	11.29	2.77
Morgan Springs Bed	2	2	2260	11.05	3.46
Mud Slip Bed	1	1	2640	4.21	.92
Nelson Bed	3	7	2340	18.73	1.11
No. 4 Bed	2	5	2220	9.08	3.62
No. 10 Bed	1	3	2150	11.42	3.14
Old Eagle Bed	1	1	2290	3.57	1.39
Old Etna Bed	1	1	2140	2.63	.76
Paint Rock Bed	6	6	2420	6.03	1.74
Poplar Lick Bed	4	11	+2610	8.36	1.84
Red Ash Bed	4	13	2570	6.13	1.13
Rex Bed	2	10	2230	5.59	1.07
Richland Bed	3	6	2590	10.53	.92
Rich Mountain Bed	5	12	2370	3.03	1.29
Sandstone Parting Bed	1	1	2380	10.34	1.26
Sewanee Bed	22	40	2460	10.02	1.20
Soddy Bed	5	9	2580	6.78	1.16
Upper Dean Bed	1	3	2290	12.02	2.29
Walden Ridge Bed	2	2	2580	8.17	.92
Alabama					
Black Creek Bed	3	12	2530	3.31	.83
Clark Bed	2	6	2350	8.68	1.06
Coal City Bed	1	3	2250	4.35	1.10
Gholson Bed	2	7	2240	6.64	.73
Harkness Bed	3	8	2460	11.51	1.57
Helena Bed	2	6	2420	8.91	.46
Jagger Bed	3	8	2690	9.81	.67
Jefferson Bed	1	4	2120	7.45	2.80
Mary Lee (Big) Bed	4	14	2830	9.90	.74
Maylene Bed	2	5	2350	8.29	.45
Montevallo Bed	1	4	2330	7.24	.76
Nickel Plate Bed	1	5	2620	4.73	.75
Pratt Bed	1	7	2430	5.49	1.59
Thompson Bed	3	10	2230	8.85	.52
Upper Straven Bed	1	2	2340	7.45	.88
Yellow Creek Bed	3	5	2370	13.90	2.91
Youngblood Bed	2	6	2130	8.62	1.08

Note: A plus sign (+) placed before a given value denotes that the true value is above that indicated.

Weighing Liquid Fuel in Engine Test

By J. S. A. Johnson*

In engine testing, while all observations should as a matter of course be recorded with the greatest care, the items of vital importance are the quantity of fuel used in a given time and the corresponding mechanical energy developed.

Very often the suction pipe, or flexible tube, is supported as shown and allowed to dip into the fuel, the lower end extending to *C*. The fuel tank should have a cover that fits closely around the suction pipe to prevent evaporation of light fuels, allowing only enough air to maintain atmospheric pressure inside the tank. With this arrangement it becomes necessary that the fuel tank rest permanently on scales unless an auxiliary supply be provided for starting up the engine and running it until the time for beginning the test. Even with the auxiliary supply there would always be some uncertainty regarding the amount of fuel that would drain back into the tank during the period of disconnecting from the system and removal for weighing.

Any arrangement of this sort, however, is unsatisfactory on account of the allowance that has to be made for the weight of the volume of fuel displaced by the suction pipe, considered as solid, between the initial and final fuel levels, 1-1 and 2-2; and in several reports of tests that have come to the attention of the writer, apparently no such allowance was made or even thought of.

That allowance must be made is evident from a consideration of the diagram. Neglecting the volume of the pipe material between the initial and final fluid levels *A* and *B*, the total downward pressure at the level *B* at the beginning of the test is greater than that at *A* by an amount equivalent to the height of a column of fluid between the levels *A* and *B*, the pressure inside the pipe at *A* as well as outside being atmospheric at the beginning of the test. At the end of the test the total downward pressure at *B* is only atmospheric over the entire section. Therefore, the fuel in the pipe between the levels *A* and *B* is supported by the scales at the beginning of the test, but not at the end. *Apparently*, then, an amount of fuel has been drawn out equal to the *total* volume between the levels *A* and *B*, and the scales will accordingly register a difference equal to the weight of this total volume, while as a matter of fact only that liquid outside the pipe between these sections has been removed. The actual weight of fuel used must therefore be calculated by subtracting from the difference recorded by the scales, the weight of a volume of the liquid equal to the volume of the dimensions of the suction pipe, considered as of solid cross-section, between the levels *A* and *B*.

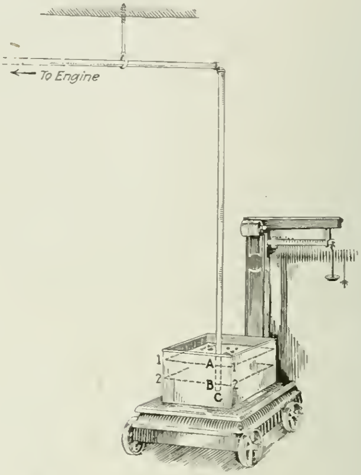

DIAGRAM OF LIQUID-FUEL-WEIGHING APPARATUS

As an illustration, let is be assumed that a suction pipe of ½-in. diameter be used, while the diameter of the fuel tank is 4 in., the cross-section of each being uniform and the axes of both pipe and tank being vertical. The sectional areas would be in the ratio of ¼ to 16 or 1 to 64, and the actual weight of fuel would be calculated from the apparent, W_a, or that recorded by the scales, by the expression,

$$W_a \times \frac{64-1}{64} = \frac{63\,W_a}{64}$$

If the diameter of the suction pipe were one inch, the correct weight would be

$$W \times \frac{16-1}{16} = \frac{15}{16}$$

The difficulty could be obviated by attaching a flexible suction connection near the bottom of the tank instead of extending into the liquid from above, but the writer has found that a carefully calibrated vertical pipe tank, with gage-glass and graduated scale, gives satisfactory results.

Despite the efforts made to convince the Senate Committee on Appropriations that the consumers of coal are entitled to statistics which would enable accurate estimates of the country's coal needs, it is practically assured that the committee will not approve the $40,000 appropriation asked for that purpose.

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The Electrical Study Course—Alternators in Parallel

Comparisons are made by hydraulic analogies, when direct-current generators are operating in parallel with the conditions when alternators are operated in parallel. Conditions that must be met for alternators to operate successfully in parallel are discussed, and the method of changing the load from one alternator touched upon.

WHEN attempting to operate alternators in parallel, it is necessary to observe the same precautions as in the case of direct-current generators, namely, that their voltages are of the same value and in the same direction. The latter of these requirements is more difficult of fulfillment in the case of alternators, since the direction of their voltages is continually changing. The only conditions under which it is possible is that they be connected together at some instant when the voltages are at exactly the same period of a cycle and that their prime movers then drive them at precisely identical speeds. To make clear the relations that exist, it will be convenient to refer back to the parallel operation of direct-current generators.

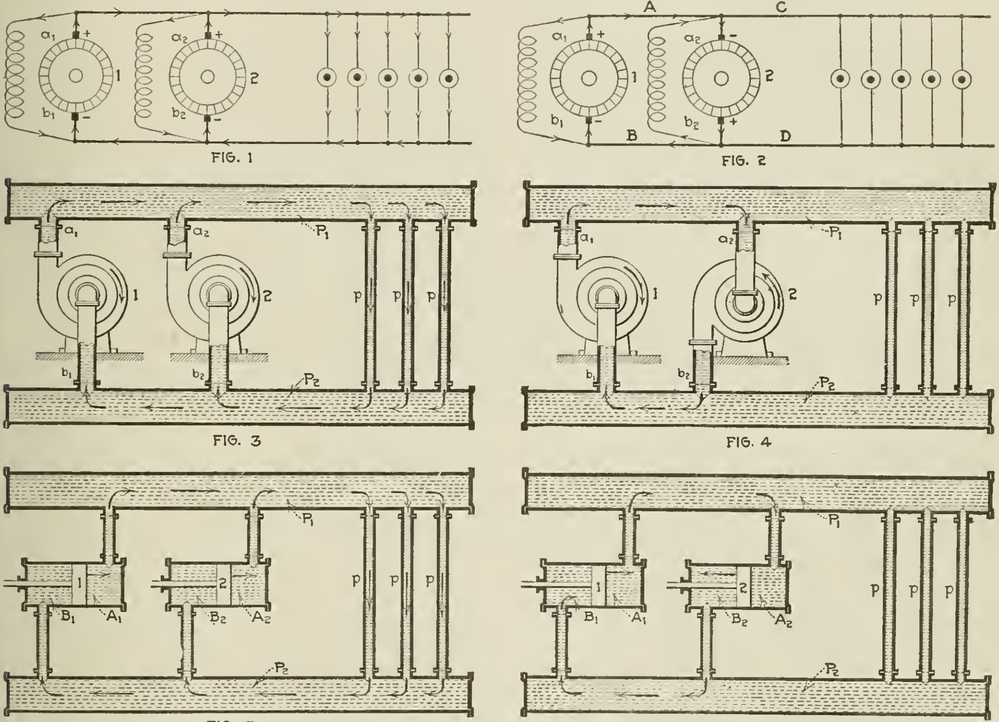


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6

FIGS. 1 TO 6. DIAGRAMS OF DIRECT-CURRENT MACHINES CONNECTED IN PARALLEL AND HYDRAULIC ANALOGIES OF DIRECT-CURRENT AND ALSO ALTERNATING-CURRENT MACHINES IN PARALLEL

Suppose that two such generators are connected together as illustrated in Fig. 1. When the polarities are as shown, each generator will deliver half of the power if they both generate the same voltage. Suppose now that the generators have been connected with opposite polarities, as shown in Fig. 2. A very large current would then instantaneously flow through the machines by way of the leads *A* and *B*, but no current would be delivered to the load through the leads *C* and *D*. As a matter of fact, the condition existing would be a short-circuit. We might illustrate the conditions of Figs. 1 and 2 by hydraulic analogies, as in Figs. 3 and 4. In Fig. 3 we have two centrifugal pumps that are rotated in the same direction and deliver the same pressure. The flow of water will be from *a* and through P_1 to the pipes *p*, and thence by way of P_2 back to b_1 and b_2. Suppose, now, that pump 2 were to be connected in reverse, as indicated in Fig. 4. It would in consequence pump water from a_2 *to* b_2, so that all the water pumped from b_1 to a_1 through pump 1 would pass through pump 2 and return to b_1 to go through the two pumps again and again. That is, water would merely be circulated around between the two pumps without causing any flow of water through the pipes *p*.

Let us assume that the rotary pumps are replaced by plunger pumps, as illustrated in Figs. 5 and 6. If both pistons are traveling from left to right as indicated by the arrows in Fig. 5, water will be forced from A_1 and A_2 into P_1, through *p* to P_2 and back into B_1 and B_2. On the other hand, if piston 2 were moving from right to left when piston 1 is moving from left to right, as in Fig. 6, the space A_2 would increase as fast as A_1 decreased, and similarly B_1 would increase as fast as B_2 decreased. Consequently, whatever water is forced out of A_1 would flow into A_2 and all the water forced from B_2 would flow into B_1. The same conditions would exist on the return stroke, except that the flow would be in the reverse direction; that is, from A_2 to A_1 and from B_1 to B_2. The result is that the water is transferred from one pump to the other, but none flows through *p*.

Let us now suppose that instead of being either directly in step or directly opposed, the pistons are actuated from cranks placed at right angles to each other, as, for example, in Fig. 7. If the crankshaft is being driven in the direction of the arrow *A*, both pistons will be moving from right to left from the position shown until the crankshaft has been turned through 90 deg. Piston 1 will then be at the end of its stroke and will begin to move from left to right, whereas piston 2 will be at about the middle of its stroke and will continue to move from right to left. The result is that during a complete revolution of the crank the two pistons are moving in the same direction at certain times and in opposite directions at others. Consequently, water will be transferred from one cylinder to the other during parts of a complete forward and return stroke, but at other times all the water will flow through *p*. The nearer the cranks c_1 *and* c_2 of Fig. 7 come to being in the same direction, the more nearly will all the water displaced by the pistos pass through *p*, whereas the nearer they approach direct opposition the more nearly will all the water merely pass from 1 to 2 without causing any flow through *p*. If the pistons were driven by separate cranks whose speeds were not the same, we should have constant changes in the conditions, ranging from all the water circulated through the pipe system, to where no water circulated in the pipes, but just within the pump only.

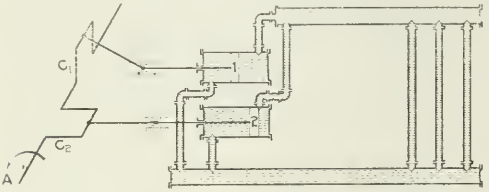


FIG. 7. HYDRAULIC ANALOGY OF TWO ALTERNATORS CONNECTED IN PARALLEL, 90 DEG. OUT OF PHASE

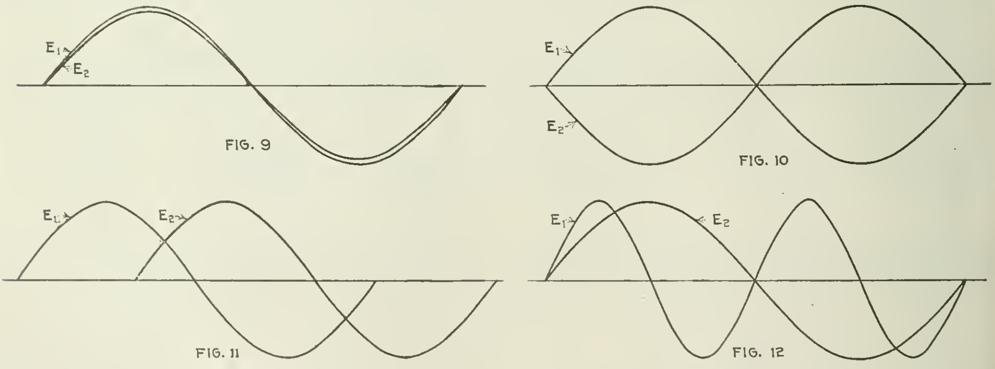


FIG. 9

FIG. 10

FIG. 11

FIG. 12

FIGS. 9 TO 12. CURVES REPRESENTING DIFFERENT RELATIONS BETWEEN TWO ALTERNATING VOLTAGES

The foregoing examples, Figs. 5, 6 and 7, may be likened to the behavior of two alternators in parallel. Thus, in Fig. 8 we have two alternators connected in multiple to a load *L*. If a_1 and a_2 are both positive, and at the same stage of a cycle—that is, if the alternators are in phase—we would have the condition of Fig. 5 and current would flow from a_1 and a_2 to *L* and back to b_1 and b_2 during one-half of a cycle and in the reverse direction during the other half. The relation between the voltages would be expressed by the curves in Fig. 9, the two being coincident. When the voltages are directly opposed—that is, when they are 180 deg. out of phase, as illustrated in Fig. 10—the conditions would be those represented in Fig. 6. If they are out of phase by some other angle, the curves in that case would have some relation, such as that in Fig. 11. If the alternators are running at different frequencies, the curves would be something such as those in Fig. 12, and the phase difference would be continually changing from zero to 180 deg.

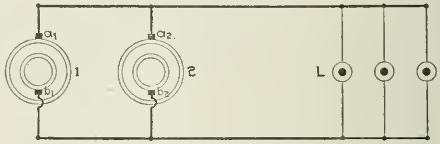


FIG. 8. DIAGRAM OF TWO ALTERNATORS CONNECTED IN PARALLEL

From the foregoing it is apparent that to prevent short-circuits between alternators when connected in parallel, they must be connected together when in phase, and that their frequencies must be the same at that time. We therefore have three things to observe when about to connect an alternator in parallel with others, namely, that its voltage is the same as that of the mains, that it is in phase with the main voltage, and that it is running at the same frequency as the rest of the systems. Once an alternator has been connected to the system, its frequency will be that of the system, under all ordinary conditions. Thus, if its prime mover tended to slow down, the alternator would act as a motor and take power from the other machines to cause the prime mover to maintain its speed. On the other hand, if the prime mover tried to speed up, it would tend to increase the frequency of its alternator, and this it could do only by increasing the frequency of all the other machines connected in parallel with that alternator.

The fact that all the machines on a system run in unison at all times, is the cause for a feature in the parallel operation of alternators that differs widely from the similar operation of direct-current generators, namely, the manner in which the load on the system is divided among the machines. In direct-current practice the generators are driven by prime movers, such as steam engines and turbines, and water turbines. The prime mover is equipped with a governor which maintains a nearly uniform speed. Not absolutely uniform, however, because it requires a slight drop in speed to cause the governor to act to admit more steam or water. Thus, when it is desired that a direct-current generator shall take a greater proportion of the load on the system, its field flux is increased by cutting resistance out of its field rheostat, thus causing an increase in generated voltage and a corresponding increase in the load current. The increase in load results in a slight slowing down of the prime mover, sufficient to cause the governor to admit the additional steam or water required by the added load. Hence, to increase the load on a direct-current generator, it is only necessary to cut resistance out of its field rheostat.

An attempt to increase the load of an alternator in the same manner would, however, result in failure. The speed of the machine being fixed by the frequency of the system to which it is tied, an increase of field current can only increase the generated voltage, but cannot make the machine slow down, and hence cannot make the governor admit more steam. Consequently, the alternator cannot assume more of the load, and the field-current adjustment does not change the load distribution. It is found, however, that such an increase in generated voltage causes a current to circulate between the generator of higher voltage and those of a lower voltage, thereby causing a greater current to flow through them than that required by the load, and consequently causing an unnecessary loss in the machines. It is therefore a part of correct parallel operation to see to it that all the machines have like excitation.

Since the load cannot be altered by field-current regulation, the question arises, How can it be adjusted? The prime movers of alternators must be equipped with governors that can be adjusted while the machines are in operation. Then, when the load is to be increased, the governor is adjusted slightly, causing it to admit more steam or water, as the case may be. This will tend to cause the machine to increase in speed. However, a very slight increase in speed will serve to make the alternator take a greater share of the load than before, and so reduce the load on the others.

In the last problem it was stated that the line ammeters of a 6600-volt three-phase system read 400 amperes at a power factor of 78 per cent. It was required to determine the total power taken by the system and to find the voltage and current for each leg of the load if connected in delta. The total power is $Kw. = 1.73 \times E \times I \times P.F. \div 1000 = 1.73 \times 6600 \times 400 \times 0.78 \div 1000 = 3562$ kw. In a delta-connected load the voltage across each leg is the same as the line voltage, and in this case, therefore, equal to 6600 volts. The current in each load is equal to the line current divided by 1.73, so that we have, load current $= \frac{400}{1.73} = 231$ amperes.

It was further required to find the same quantities as in the foregoing, when the power factor is 72 per cent. and the load connected star. The power will, as before, be $Kw. = 1.73 \times E \times I \times P.F. \div 1000 = 1.73 \times 6600 \times 400 \times 0.72 \div 1000 = 3288$ kw. In a star-connected load the voltage across each leg is equal to the line voltage divided by 1.73, so that we have, load voltage $= \frac{6600}{1.73} = 3806$ volts. The current per leg is the same as the line current, namely, 400 amperes.

In a balanced three-phase system the wattmeter indicates 150 kw. The load is connected delta, and ammeters and voltmeters connected into each leg indicate 300 amperes and 220 volts, respectively. Find the line current, the load in kilowatt-amperes and the power factor of the system.

Electric Welding of a Diesel Cylinder Head

By L. H. Morrison

An interesting repair was made some time ago on one of two used American Diesel engines purchased by a light and power company. These engines were to be used in the tropics. It is well known by the majority of Diesel operators that this make of engine has a decided tendency toward fracturing the cylinder head at the point *A*, Fig. 1. It is apparent that this bridge is alternately cooled by the air entering through the admission valve *C* and heated by the hot gases blowing out through the exhaust valve *B*. This produces at *A* surface fractures that gradually extend through the entire bridge. As soon as the fracture appears at *D*, the cylinder compression is lost.

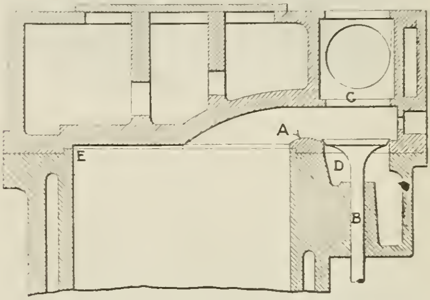


FIG. 1. SECTION OF DIESEL CYLINDER HEAD SHOWING BRIDGE WHERE CRACK OCCURRED

The engine referred to had all three cylinder heads fractured at this point. One of the bridges had opened up about $\frac{1}{16}$ in., while the other two merely showed cracks which, though minute, extended entirely through the bridge. It was found advisable to weld these before shipment. Since the joint at *E* employed no gasket, being ground to a fit, electric welding was resorted to in order to avoid danger of distortion of this ground joint, experience having proved that acetylene welding invariably warped the bridge.

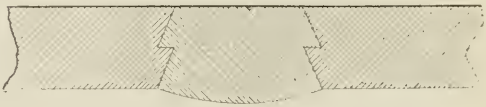


FIG. 2. SECTION OF BRIDGE SHOWING HOW CRACK WAS WIDENED TO FORM KEY FOR NEW METAL

In preparing the head for the welding operation, the fracture was widened to about two inches. The groove was made with a key, or offset, in order to lock the added metal in case the weld was not absolutely successful. A cross-section of the break after the new metal was in place is shown at Fig. 2.

In the welding operation, since only alternating current was available, a special form of auto-transformer was used, giving about 70 volts at the transformer terminals. This was further reduced to 55 volts at the tip of the welding iron by the resistance of the iron and wiring.

When adding the new metal, the bottom of the cut was filled with molten metal and water sprinkled on it for cooling purposes. The surface of this added metal, since it oxidized rapidly, was cleaned with a wire brush and more metal added. This was continued until the entire cut was filled.

The head as it appeared after the welding operation was finished is shown in Fig. 3, the lighter portion being the new metal above the surface of the head. This metal, of course, had to be smoothed off so as to make a joint with the cylinder casting. A portable grinder was used in removing most of the excess metal; this was followed by filing and scraping. The new metal had all the appearance of steel rather than of cast iron, and the application of the water had hardened it to such an extent that filing was almost impossible. A view of the head after the grinding and filing was completed is given in Fig. 4. As the illustration shows, the new metal did not actually unite with the iron of the head, the bond was rather a mechanical one and the key, Fig. 2, apparently held the weld. Doubt was felt as to the service to be expected from these welded heads since it was believed that as soon as they warmed up the weld would let go. Fortunately, no such trouble has appeared.

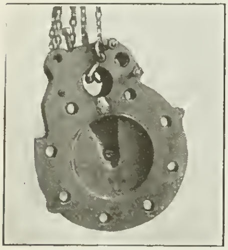


FIG. 3. WELDED HEAD BEFORE GRINDING

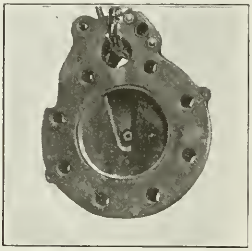


FIG. 4. WELDED HEAD AFTER GRINDING

Illinois Forced-Draft Chain-Grate Stoker

The Illinois Stoker Co. has recently placed on the market a forced-draft chain-grate stoker with which rates of combustion as high as 70 lb. of Illinois bituminous coal per square foot of grate surface per hour have been maintained. Air is supplied under pressure, as by the blower *A*, Fig. 1, to a windbox in the side wall. U-shaped tuyere boxes of 12-gage sheet iron extend across the furnace, being bolted at their ends to flanges cast upon the side frame, and at their tops to cross-girders. In the larger installations it is necessary to supply air from both sides of the furnace.

The air is admitted to the tuyere boxes from the windbox through the cast-iron sleeves, which enter the circular flanged openings in the side frame and are removable to permit the withdrawal of the stoker. The admission of air to the tuyere boxes is controlled by means of hinged dampers in these sleeves, or by means of long cast-iron dampers operated through the side wall and located in the tops of the tuyere boxes. These long dampers are attached to spindles which terminate outside the setting wall in handles provided with means of securing them in the fixed position desired. These handles are shown at *D* in Fig 1.

Upon the cross-girders are longitudinal girders on skids which carry the grate. These skids have hardened surfaces and have been adopted instead of rollers for the purpose of maintaining the surface of the grate level and reducing the amount of drippage, also to avoid trouble with rollers becoming fouled.

In some of the stokers at present in operation the skid bars are used only for the top grate, the roller construction being retained at the bottom, as shown at *E* in Fig. 2. In the later types, however, skids for carrying the returning grate are used. These are iron beams, 1 in. thick by 7 in. deep, set on edge in the foundation and extending the full length of the grate.

The grate slides along the tops of the tuyere boxes upon the hardened skids, as shown in the elevation Fig. 2 and upon a larger scale in Fig. 3. The air passes from the tuyere boxes upward through the openings in the grate to the fire.

In forcing air through the grate some means must be provided that will prevent the longitudinal leakage of

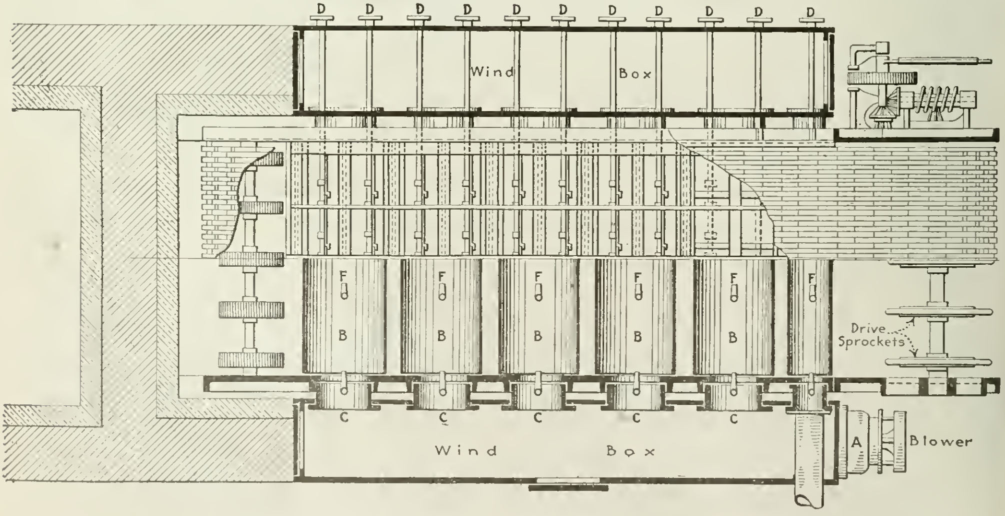


FIG. 1. PLAN VIEW OF ILLINOIS FORCED-DRAFT CHAIN GRATE STOKER

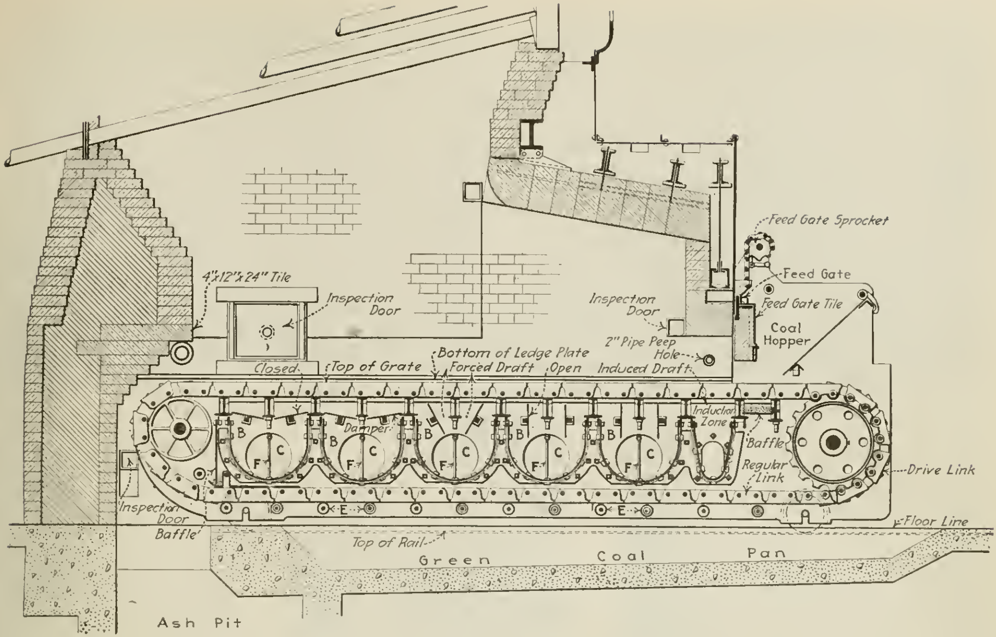


FIG. 2. SECTIONAL ELEVATION THROUGH STOKER AND FURNACE

air along the links. This is accomplished by providing a small, narrow, vertical rib on the link, so located that the air in passing longitudinally along the grate must zigzag around these ribs. The tortuous path thus imposed on the passage of air along the grate reduced leakage due to this cause to a negligible amount. At the top of this rib and parallel to the top of the link is a small apron designed to prevent excessive drippage of fine particles of coal between the ends of the links. This link is designated as the "regular link" and forms the body of the grate. In addition there are three other special links—the drive links, the side or seal links, and the center links. The center links are necessary only in the use of the double-drive stokers. The drive links are designed to permit the insertion of a drive roller between them. The drive rollers engage the teeth of the drive sprockets keyed to the front shaft.

All stokers 10 ft. wide and over are provided with double drives; that is, the grate is composed of two individual chains, each driven separately. There is a decided advantage in this method, inasmuch as the fire can be maintained uniform across the grate by speeding up or slowing down either side as necessity may require. The additional advantage gained by the double drive is the elimination of distortion due to the unavoidable torsional deflection of a long driving shaft.

Siftings are removed from the tuyeres by means of steam or air jet blowers, indicated at *F* in Figs. 1 and 2, which deliver the siftings into the windboxes, out of which they are removed by hand through hinged doors.

The stoker has been adapted to the burning of several classes of fuel by slight changes in the design. The small tuyere in front, shown in Figs. 1 and 2, is not used in stokers designed for burning bituminous coals. It is not a pressure tuyere as are the remaining ones, but is connected to an exhaust fan and is termed the induction zone. Its purpose is to maintain the ignition when burning anthracite and lignites. It has been found that the use of the induction zone for burning anthracite culm is not necessarily continuous, but at times, when for some reason the ignition tends to leave the feed gate, the induction must be used. When burning lignite the drying out of the fuel is materially aided by means of the induction zone.

In a certain installation that has been in service for some time each tuyere or zone is supplied with air by means of a separate turbo-blower. Tests on the installation gave a combined efficiency of 73.3 per cent., which could probably be increased to 76 per cent. by converting the open waterbacks and water-cooled clinker plates into the closed type. At normal rating the boiler is designed for 500 hp., and the records show an average for 24 hours of 1370 hp.

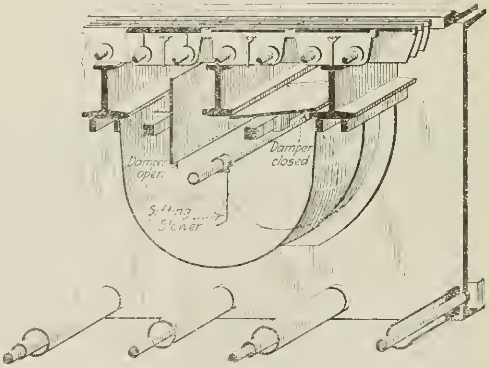


FIG. 3. DETAIL OF ONE BLOWING ZONE

Systematic Study of Boiler Performance

How the Emergency Fleet Corporation Studies Its Water-Tube Boilers for Different Methods of Baffling, Hand and Automatic Stoking, and Oil Firing

THE success of the merchant fleet, the construction of which was undertaken by the Emergency Fleet Corporation, depends in no small degree upon the effectiveness and efficiency of the boilers with which it is equipped. Never before, perhaps, has so large an enterprise been started with so clean a slate and with such an opportunity to evolve the apparatus best adapted to the required service.

A study of boiler types indicated that, under the conditions, the water-tube type led in advantages. The Scotch marine boiler, on account of the impracticability of transporting it by rail intact, could be manufactured only on the seaboard. Heavy plate was difficult to procure because of other demands, and there is about two and a half times as much steel in a Scotch as in a water-tube boiler of the same capacity. The water-tube type could be built by numerous shops all over the country and easily transported to the coast, and its cost was about one-third of that of the Scotch marine.

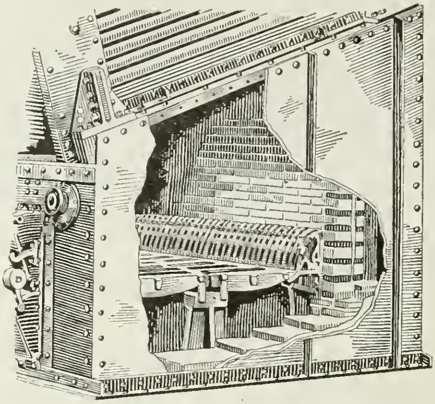


FIG. 1. WAGER BRIDGE-WALL IN MARINE WATER-TUBE BOILER

If the performance of steam boilers had been studied scientifically and only those best adapted to the fuel and conditious used since the boiler became a large factor in industry, an immense amount of fuel would have been saved and the cost of the products of industry would have been correspondingly reduced. The Emergency Fleet Corporation was buying about 1400 boilers of one design and size, all for the same kind and size of ships, and was afforded an opportunity to determine what results were obtainable, and what design, proportions, baffling, accessories and methods of operation would produce the best results.

Among those whose aid was enlisted by the Emergency Fleet Corporation in carrying out its work was the well-known mechanical engineer and boiler expert, F. W. Dean, of Boston, and one of his duties was that of testing the boilers produced. The activity developed into more than the determination of accomplished results by the opportunities which it offered of finding out how those results could be improved.

At the shops of the Erie City Iron Works the writer saw in operation under test conditions one of the Emergency Fleet standard water-tube boilers for wood ships built by the Erie City Iron Works, equipped with every conceivable sort of apparatus for determining what was going on within. The boiler was designed by the Emergency Fleet Corporation; has a cross-drum and water-legs, the latter being fitted with key caps. There are 409 three-inch tubes of 7 ft. 7½ in. exposed length, the total heating surface of the boiler being 2510 ft. It was fitted at the time with two Type E stokers, but had been tested with various types of furnaces. The grate area for hand firing was 77.45 sq. ft., and the pressure carried was 200 lb. The three upper baffles are of plain uncovered seel plate, and the lower one of tile.

For hand-firing, fixed grates and in-swinging counterweighted doors were used, the latter being surrounded by perforated hollow jambs and lintels admitting an un-

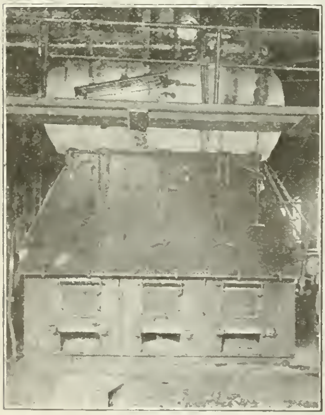


FIG. 2. FRONT OF BOILER, SHOWING FIRE DOORS

FIG. 3. OBSERVATION PLATFORM AT REAR OF BOILER

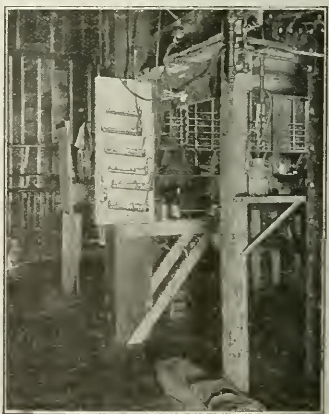


FIG. 4. DRAFT GAGES AND MEASURING INSTRUMENTS

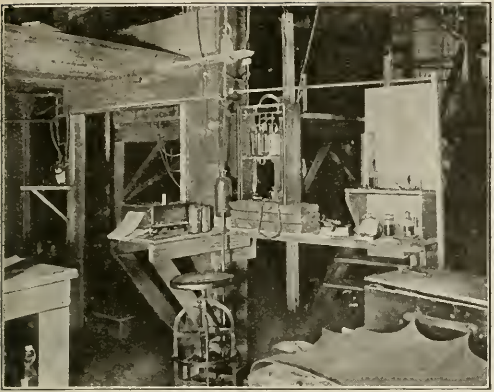


FIG. 5. ORSAT APPARATUS FOR ANALYZING FLUE GAS

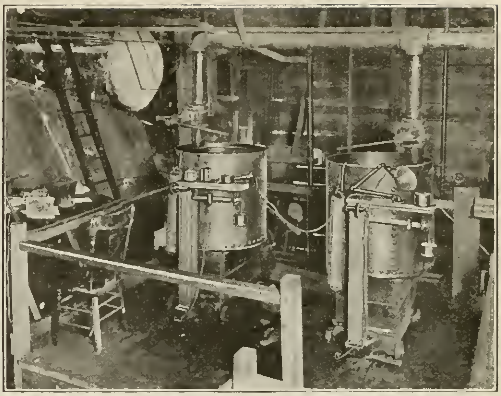


FIG. 6. TANKS AND SCALES FOR WEIGHING FEED WATER

usually large supply of air over the fire. This was supplemented by the use of the Wager bridge-wall, Fig. 1, which admitted air and cleared up a space of triangular cross-section toward the rear of the furnace where the combustion had been faulty. Capacities were obtained with hand firing up to 213 per cent. of land rating, but with the stokers the capacity was carried up to 306 per cent. of land rating, with an efficiency of 71.5 per cent. The best efficiencies obtained were 73.3 per cent. with hand firing and 79.2 per cent. with mechanical stokers, at evaporations of 5.83 and 5.3 lb. per square foot of heating surface respectively from and at 212 deg. The maximum rates of evaporation per square foot of heating surface per hour from and at 212 deg. were 7.4 lb. by hand firing and 10.57 lb. with the stokers, respectively. The boiler was set in a steel casing, and different kinds of refractory and heat-insulating lining materials were tested. Thermocouples indicated the temperature of the firebrick and of the outside of the steel casing, while thermometers showed that of the contiguous air.

Measuring Coal and Air

The coal was weighed on platform scales, and from it 1000 lb. was taken each 24 hours for sampling. There were counters upon the feeding mechanism of the stokers. When the stoker was used, the quantity of air admitted to the furnace was measured by calibrated orifices in a galvanized suction chamber connected to the fan that supplied the air. The gases were sampled at fifteen places in the furnace, three in the first pass and in the center of the uptake.

There was a draft gage between the end of each baffle and the nearest header and a movable exploring tube passing through hollow stay-bolts enabled the velocity and paths of the gases at various points to be determined. This velocity reached at some times and points 50 ft. per sec. Many inert localities were found, notwithstanding which the efficiencies kept up wonderfully.

There was an arrangement whereby a metered quantity of gas could be withdrawn from the furnace and analyzed for tar. Soot blowers were provided, and the conditions under which the boiler was operated furnished an opportunity for observing the effects of its use. With George's Creek Cumberland coal, hand-fired, the temperature of the uptake gases would increase about 35 deg. in two hours after blowing the tubes. With the stoker there was no noticeable rise in the uptake temperature two hours after using the soot blower. A Bailey boiler meter furnished a guide to the firemen.

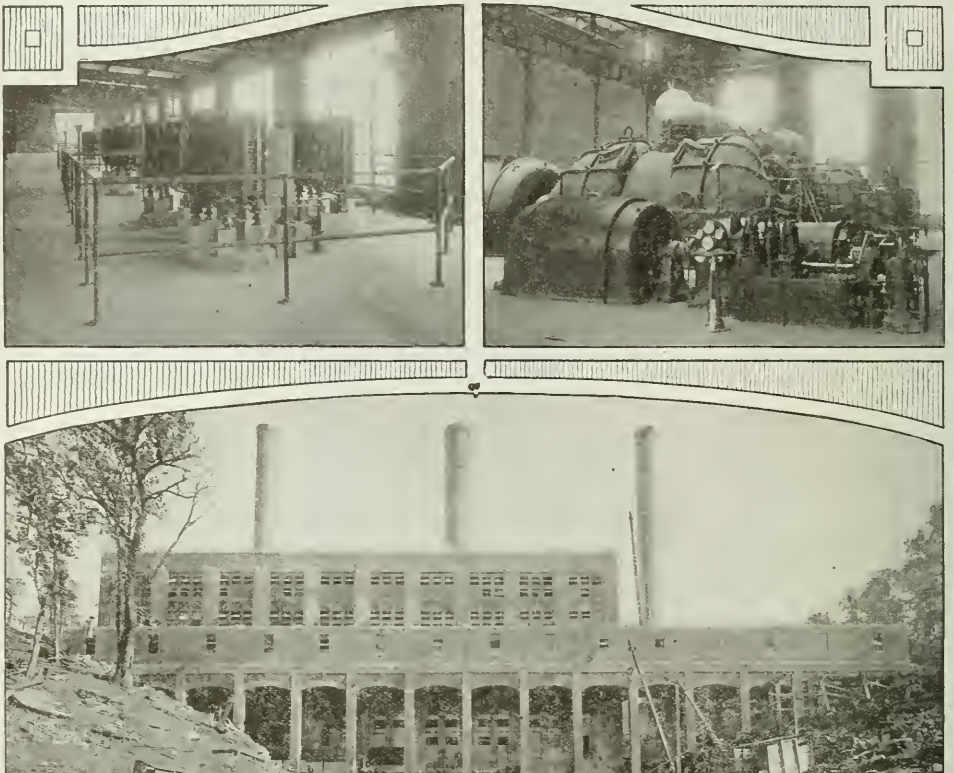
The uptake temperature was taken by five thermocouples, movable across the uptake, the temperature being taken at eight points in the traverse by each couple. A stationary couple at the center of the uptake served as a check.

The water was weighed in the tanks shown in Fig. 7 and discharged into a suction tank provided with a hook gage for establishing starting and stopping levels. The feed-water temperature was taken by a thermometer in a well in the feed line near the boiler. The direction of flow and velocity of the water in the boiler tubes was shown by eight propellers on shafts passing through stuffing-boxes in the key caps. These propellers were in a vertical plane, and gave an accurate idea of the circulation. The shafts were almost frictionless, and the number of revolutions was recorded by an electrical apparatus. A pneumacator allowed the water level to be read at the observer's desk or any other desired point or points.

A throttling calorimeter determined the quality of the steam, and a U-tube the loss of pressure through the dry pipe. The exhaust from the stoker engine was condensed and weighed. Draft up to 2⅝ in. could be produced with a steam jet.

Tests have been made with different methods of baffling, with hand and automatic stoking when burning coal, and with several kinds of oil burners, demonstrating the possibility of maintaining efficiencies of 72 to 79 per cent. It is to be hoped that the results will some day be available to the public.

With the regulation of electric utility rates to provide only sufficient return on capital investment to attract new capital to meet the constant demands for expansion and development, and with a courageous attitude on the part of state regulating bodies to see that such reasonable return is allowed to utility companies, the electric industry is free from politics and may devote its entire energies to its duty of adequate and comprehensive service to the public. Broad, honest and courteous service at every point of contact with the public makes for contented and satisfied consumers. We all know that a sound, substantial income, as the result of good service to contented patrons, is much more to be desired than income based on unnecessary consumption of energy and indifference to the real interests of our consumers.—*R. H. Ballard, Pres. National Electric Light Association.*



RECENT VIEWS POWER PLANT, AIR NITRATES NO. 2, MUSCLE SHOALS, ALA. CENTER: VIEW OF THE STATION FROM THE RIVER. UPPER LEFT: REACTANCE GALLERY. THE MAIN 60,000-KW. TURBINE AT THE RIGHT. LOWER LEFT: THE BOILER ROOM. LOWER RIGHT: INTERIOR TURBINE ROOM, TWO 15,000-KW. UNITS IN FOREGROUND

EDITORIALS

An Announcement to Our Readers

THE editor would like to write to each one of you and thank you personally for the gratifying support that you have given us during the attack upon us of the printing unions. Despite the fact that eight issues of *Power* have been delayed on account of this trouble, we have not received one letter reproaching us for this delay from our thirty-four thousand subscribers.

Our advertisers have been equally generous with us. They have told us to go ahead and repeat their copy as often as expedient. The combined coöperation of subscribers and advertisers is of course something that we appreciate highly.

While we cannot say that our troubles are altogether over, we are getting out of the woods and our press room and composing room look almost normal again. Two courses are open to us. One is to catch up as fast as we can with these delayed issues, bringing out an issue, say, every five days until we are again even with the calendar. The other alternative is to double up the editorial section for enough issues to bring the reader up to date by the first of the year.

This latter alternative, it is hardly necessary to say, is vastly more expensive inasmuch as we, by so doing, will omit the equivalent of five complete issues of advertising. We feel, however, that it is a matter of duty on our part to bring the reader up to date with his issues just as soon as possible, and also a duty on our part to pay the cost of this strike out of our own pockets and not pass it along to the advertiser. It is the McGraw-Hill Company's cash contribution toward sane American industrialism.

In this issue, therefore, we are publishing a double editorial section covering the issues of Oct. 28 and Nov. 4, with the advertising section that corresponds to one issue only. We plan to double up in this way until the end of the year and, having caught up with the calendar, hope to greet you as regularly and heartily each week in the future as we have in the past.

Power Plant Wages

The table in this issue showing wages paid in power plants will not only interest operators themselves, but will also be an aid to employes in assisting them to determine whether they are paying above or below the prevailing wage for the size and type of plant concerned.

One point is clearly brought out by this investigation. There is not only great diversity in wages as concerns type and size of plant, but there is also wide variations among similar plants. The pay in many of the smaller plants is ridiculously low, considering the responsibilities carried and the qualifications necessary. This is especially evident when comparison is made with the prevailing wages in many of the trades requiring infinitely less training and skill. On the other hand, the operating men in many of the larger plants are receiving what may be considered fair compensation for their services. In certain sections the union men are found to be better off as concerns both hours and wages, although in other instances non-union plants will be found paying above the union scale. In fact, it will be noted that there is considerable variation in the union scales themselves.

Statistics published recently by the New York State Industrial Commission indicate that the average weekly pay received by employes of water, light and power plants in New York State is at present $28.80, compared with $15.37 for 1914, an increase of 87 per cent. In New York City the figures are slightly higher, being respectively $29.36 and $16.21. While this has just about kept pace with the increased cost of living, it is evident that the figures for 1914 were abominably low.

Size and Capacity of Single-Shaft Steam Turbines

PRESENT limits of the size and capacity of single-shaft steam-turbine-driven units furnished an interesting subject for the recent New York meeting of the American Institute of Electrical Engineers. The turbine designers agreed that the limit of a single-unit turbo-generator does not lie in the generator, but in the steam turbine and in the last wheel of that. The Westinghouse man said that this limitation might be avoided by making the turbine in two or three separate compounded elements, each driving its own generator and each capable of operating alone on high-pressure steam in emergencies. The General Electric man said, in the discussion, that inasmuch as each element had to have its own generator, one might perhaps better avoid the problems of the large-capacity unit by dividing the installation into a number of identical units of smaller capacity than into a number of dissimilar units forming the successive stages of a compound of large capacity.

The electric-generator designer said that, as far as the generator is concerned, with speeds of twelve hundred revolutions per minute and lower the stator, and with higher speeds the rotor, is the limiting member. If operating engineers want units of fifty thousand to one hundred thousand kilowatts, there is no question but that such generators can be conservatively designed and constructed.

Representatives of the General Electric Company explained that several of the accidents that have occurred to large turbines of the single-shaft type were due to fluttering and vibration of the wheels, which had been brought about by making them too thin in an effort to save weight and space. The stresses due to centrifugal force were less than those in wheels made from weaker material that had operated for longer periods of time, but the vibration gave a periodic character to the stresses and gave rise to the formation of fatigue cracks. Stiffening the wheels and putting the openings in them nearer to the hub, where a suitable reinforcement could be provided, had overcome the trouble.

A striking demonstration of the action that was taking place was furnished by experiments with rubber disks at Schenectady. These disks, made to simulate turbine wheels, were rotated at high rates of speed and were illuminated by static sparks discharged by a contact point upon the revolving shaft so that the illumination came when the disk was in the same position each time, and to an observer it appeared to be standing still. By watching these disks at various speeds, they found out many things that they were looking for and one, at least, that they were not. On one of them that was particularly thin and quite light at the rim, a sinuous distortion appeared and worked around the circle at a speed varying with, but not proportional to, the number of revolutions per minute.

The magnitude and complexity of the problems with which the turbine designer has to deal were brought out in the discussion, and the utter impossibility of the development of apparatus of this sort except by establishments having such resources in brains, money and facilities as those represented in this discussion presented itself. If we had known all about the principles and possibilities of the steam turbine a half-century ago, it is doubtful if we could have progressed much faster than we have done in its development and application. For this not only superior tools and workmanship, but organizations which could carry it through the development stages to a successful issue, were necessary.

American vs. Foreign Practice

THE article in this issue of *Power,* describing the Newport Power Station in Melbourne, suggests some interesting comparisons between American and foreign practice in power-plant design. The plant referred to has a total capacity of sixty thousand kilowatts and this is supplied by six separate ten thousand kilowatt units. Judging from American practice, if the plant had been in this country it would probably have been equipped with two units of thirty thousand kilowatts capacity each, or perhaps three units of twenty thousand kilowatts each.

American engineers have worked more and more toward the larger units with the object of savings in first cost, space requirements and operating costs. On the other hand, from the viewpoint of reliability and flexibility the plan of using a larger number of small units instead of fewer units of larger capacity has much to commend it. From the point of economy of operation a thirty thousand or even sixty thousand kilowatt machine need not be very much better than a ten thousand kilowatt unit, and this advantage may often be wiped out by the necessity of running the large unit below capacity a good port of the time. From the point of reliability a breakdown of one machine in a plant having six is obviously much less serious than a breakdown of one unit where there are only two or three.

Another point differing from American practice is the use of two separate casings for the high- and low-pressure cylinders of the turbine in ten thousand kilowatt units. American engineers would probably have used only one casing for machines of this size. Here, again, the foreign method has certain advantages. The temperature range for a single casting is much reduced when two casings are used. Since it is possible to make the high-pressure cylinder single-flow while using the double-flow type for the low-pressure cylinder, the range of blade lengths is much reduced. Both these result in lower stresses in the various parts affected and therefore in simpler design.

We do not want to condemn the use of large units or of the single cylinder, but simply call attention to a plant which illustrates a departure from American practice and to the fact that there are sometimes very good reasons for such a departure.

Fuel Oil and Excess Air

THE instability, or apparent instability, of the coal market along the Atlantic Seaboard is causing many plants to change from coal to oil. Nearly all the plants that have made the change and those that will make it have stacks designed for coal burning. It is well known that it requires more air to burn a pound of oil than to consume a pound of coal. On the other hand, it is not so generally known that losses due to excess air invariably are very much greater than when burning coal, until the crew has become accustomed to oil burning.

A word of caution therefore is not amiss.

The back damper should always be open enough to allow the gas in the furnace to escape if the burner snuffs out and there is no flame to consume the gases. Otherwise there is likely to be a serious explosion. The draft regulation should be by adjustment of the ashpit door or its equivalent. Unless care is used in the regulation of the air of combustion, the many plants now beginning to use fuel oil will be responsible for considerable losses.

The boiler and breeching or uptake from each boiler should be provided with peepholes. Beginners usually get the impression that a white fire is an economical fire. Usually, it is not. White indicates excess air, gray and black too little, and yellowish white and orange just right.

T-Wharf Refrigerating Plant

THE last few years have been active ones in the refrigerating industry, particularly in the development of the high-speed ammonia compressor. Several interesting plants using high-speed machines have been built. Of these surely none is of greater interest than the new T-wharf plant of the Quincy Market Cold Storage and Warehouse Company. This plant is electrically driven by purchased current.

No need here to go into details; the article describes those. The occasion for some comment is that here is a plant so designed and equipped that advantage should be taken to make many tests to determine what plants of this new design can be made to do. Connections are such that condensers and coolers may be operated in any desired manner of water and ammonia gas flow. Thermometer wells abound so that all test temperatures may be had. The plant is in Boston, and it would be worth while indeed, when fully ready, to let the students of the Massachusetts Institute of Technology, under the direction of Professor Edward F. Miller, test the plant for various purposes.

Power Plant Record Forms

THROUGHOUT the year we have many calls for power-plant record forms, daily report sheets, etc. We do not have these. The forms that are successful in one plant are not usually applicable to another. We publish in the course of a year, various record and report forms as used in specific plants. It is from a study of these and others which one may find available that one may draw up forms suitable to one's own plant.

The weakness of most forms is that they are too elaborate. The initial forms which the engineer gets out after considerable effort and time spent, usually call for so many entries that they actually overwhelm the men, annoy them and eventually are ignored. Where one finds a plant using the same forms for years one will learn, upon inquiry, that those in use are the result of many, many rejections and revisions.

CORRESPONDENCE

Unequal Air Gaps Cause Complex Exciter Problems

A peculiar case of trouble occurred in a new station, in which two exciters of identical design and manufacture refused to operate in parallel with any degree of success. The exciters were compound-wound and controlled by a Tirrill regulator. When using a Tirrill voltage regulator on exciters operating in parallel, it is necessary that the voltage regulation of the individual exciters be the same if equal division of the load is to be obtained between them. Proper load division between the machines is usually obtained by adjusting the compounding of the units.

In the present instance voltage-load curves had been taken and adjustments made, yet no adjustment permitted the two exciters to share a changing load equally. Equality of load could be obtained at any time, but if the load changed, one machine would pick up the increase in load while the other would carry only its previous load, or even in some instances lose a portion of that.

A resistance was then inserted in series with the series winding of the machine that took more than its share of the load, this resistance being connected inside the shunt connection. The effect of this was, of course, to cut down the current passing through the series winding of the machine, hence its compounding, and a readjustment of the auxiliary rheostat became necessary. But even so, this machine still picked up any load increase at a much more rapid rate than did the other machine. A further reduction of the compounding was without result.

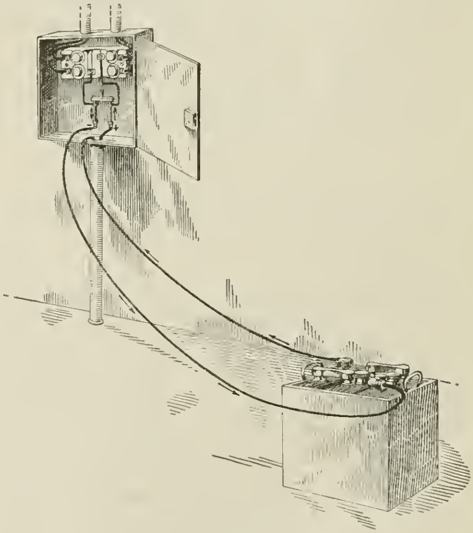
A readjustment of the settings of the brushes of both machines was made, but while improving matters somewhat, had a very slight affect on parallel operation. In fact, the machine that has previously refused to pick up any load increase began to pick up about 10 per cent. increase as compared to a 90 per cent. increase taken by the other machine. About this time a saturation curve of the sluggish machine was taken. The curve showed that the terminal voltage answered very slowly to the current increase or variation in the field, and this held true at all points of the saturation curve. This curve immediately suggested that there was something wrong with the magnetic circuit of this machine, and an examination soon brought to light the real cause of all the trouble. The air gap was considerably greater than that of the more sensitive machine. Shims, or liners, were procured and inserted between the polepieces and the yoke so as to reduce the air gap between the polepieces and the armature. After repairs a few adjustments of the compounding enabled the two machines to be operated in parallel by the functioning of the Tirrill regulator. B. W. SMITH.

Cicero, Ill.

Charging Batteries from Lighting Load

The problem of recharging an automobile starting and lighting battery was put up to me recently, with the request to do it without any unnecessary expense. In our machine shop we have twenty 16-cp. incandescent lamps operating on 110-volt direct current. This load is equal to about 10 amperes and seemed to be the most convenient resistance to connect in series with the battery to limit the charging current.

I determined the positive and negative terminals of the lighting switch and disconnected the negative wire, connecting this to the negative terminal of the battery and the positive of the battery to the switch, as indicated in the illustration. This allowed me to charge the battery and still have enough light in the shop without making up a charging rheostat.



CONNECTIONS FOR CHARGING THE BATTERY

Newark, N. J. ALFRED MESLAR.

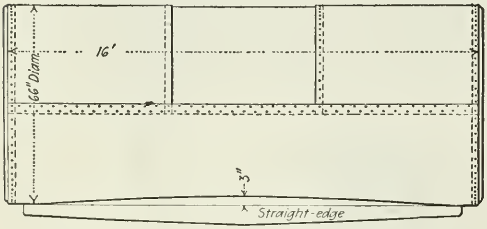
The Length of Boiler Seams

Having had the opportunity as a boiler inspector to see quite a number of boilers with what is known as continuous seams at the longitudinal joints, the invitation on page 191 of the July 29 issue attracted my attention, and my observations may be of interest to the readers of *Power*.

The bottom halves of these boiler shells were constructed of single plates, with the tops in most cases made up in three courses. All these boilers had been in service for quite a number of years, and almost invariably the bottom half, which was made up of a single sheet, was found to be warped in the manner indicated by the sketch. In applying a straight-edge to the bottom of one of these boilers, which was 16 ft. in length by 66 in. in diameter, it was found to be three inches out of line. It is not probable that so much distortion could take place without producing severe and very unequal strains upon the longitudinal seams, whether of lap-riveted or butt-strap construction.

In the case of a boiler made up of two or more courses, one plate to a course, this kind of distortion is hardly ever perceptible, probably on account of the stiffening effect of the circumferential seams.

The butt-strap joint could withstand greater stress than the lap joint, but by breaking up the longitudinal joint with two or more courses, the safety of the boiler is increased, and the length of butt-strap joints as well as lap joints should be limited in the case of externally fired boilers.



DISTORTION OF BOILER SHELL WITH LONG SEAM

In horizontal water-tube boilers I believe that the drums should be constructed of more than one course on account of stresses introduced by attaching the tubes and water-legs to the drums, for if the utmost care is not exercised when erecting, a full bearing is not maintained at all four corners, and the tubes and drums are subjected to a twisting strain. The tubes, being light, quickly adjust themselves to meet the condition, but the drums are left to withstand these strains.

I have often found, in boilers of the horizontal water-tube type, throat and girth seams that persisted in leaking in spite of being calked several times. As these boilers were entirely free from scale or other harmful deposits, no other reason could be found for this leakage except the twisting strains along with expansion and contraction. When such stresses are resisted by the longitudinal seams, the safety of the boiler is decreased that much, and I believe this is argument enough to limit the length of the longitudinal seams on this type of boiler.

Water-tube boilers of the Stirling type are usually suspended in such a way as to make the drums quite independent of one another, and their connections being so flexible as to permit the drums to adjust themselves to varying conditions, these boilers are not subjected to so many different strains as other types, and it is not so essential to limit the length of their longitudinal seams. P. E. Terroy.

Chattanooga, Tenn.

Refrigerating Effect of Natural and Artificial Ice

Is there any more refrigeration in a pound of ice that is frozen by nature on a pond, lake or river, than there is in a pound of ice frozen by artificial methods in an ice plant?

I have had considerable experience working in ice plants and have noticed that the artificial ice melts faster and that if a piece of it is put in the mouth it can be kept there without any discomfort, while if the same thing is done with a piece of natural ice it immediately chills the tongue and has to be taken from the mouth. Also, I have observed that ice water made by melting artificial ice can be drunk much more readily than ice water made from natural ice. An engineer friend of mine claims that ice is ice no matter what the conditions are under which it is frozen. I have also noticed that when I have frozen can ice in three or four hours with the brine down to 0 deg. F., it has not the refrigerating effect of the clear ice frozen over a longer period with 20 deg. brine. This may be due to the large amount of air trapped in the ice that is frozen quickly, which would have the effect of cutting down the weight per can. James S. MacDonnell.

Rutland, Mass.

["Pigs is pigs," and so ice is ice. But this question is one often in the minds of engineers, and housewives swear that artificial ice melts faster than natural ice. And this is quite possible. However, of two pieces of ice, one natural and one artificial, of equal volume and equal weight and both at the same temperature, the refrigerating effect of one will be no greater or less than that of the other. Perhaps some readers will not agree; however, good discussion of the subject will be published if sent to us.—Editor.]

Engine Running Twenty Years

I have a 68-hp. Corliss engine running over at 80 r.p.m. This engine I believe has been running twenty years and runs with a three-quarter load all of the time.

The bottom shoe has been babbitted once; the piston-rod is packed once a year. If the packing shows leaking steam after six months' use we remove two rings of packing and replace them with new ones. In this way the packing lasts six months longer. There are five rings altogether. Valve rods are packed every two years. Two liners have been put in on the crosshead brasses and two on the crankpin brasses, also two sets of catch blocks have been replaced. One set of leathers were put on bottom of the dashpots and one set of springs on the exhaust valves.

A pressure of 80 lb. of steam is carried on the boilers. We never let the lubricator run empty, and use one quart of oil each day of ten hours. I have no intention of overhauling the engine as it does not need it.

New York City. Patrick Molloy.

Averaging Pressure Charts

The accompanying pressure-gage charts are presented in order to show how the average pressure may be arrived at by means of a planimeter. I have never seen this idea published, but for all that it may not be new.

Take, for instance, the chart shown in Fig. 1. The irregular pen line makes it difficult to determine what the average pressure is. By using my method, the average is easily obtained. The process is as follows: Run a planimeter over the entire irregular pen line. This will give an area of 9.3 sq.in., which is the area of a circle 3.44 in. diameter. Striking a circle on the chart 3.44 in. diameter, as shown, it will give an average pressure of 57 lb.

The same idea is worked out in obtaining the average pressure when the curve is less than a complete cycle of 24 hours. First project the hour lines to the center of the chart as shown in Fig. 2. Then run a planimeter over the pressure line and the hour lines *AB* and *AC;* the area will be 2.10 square inches. From 8 a.m. to 12 noon is 4 hours, or ⅙ of 24 hours. Then 2.10 × 6 = 12.6 sq.in., the area of a circle of the same diameter, or the segment of a circle shown by the pen line, a circle to contain 12.6 sq.in., would be just 4 in. in diameter. Then drawing a 4-in. circle on the chart will indicate 80 lb. to be the average pressure during the 4-hour period. W. V. White.

Hamilton, Ohio.

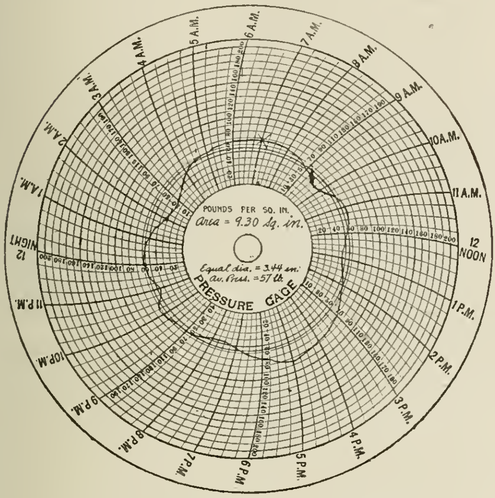


FIG. 1. COMPUTED AREA OF AN IRREGULAR 24-HOUR CHART

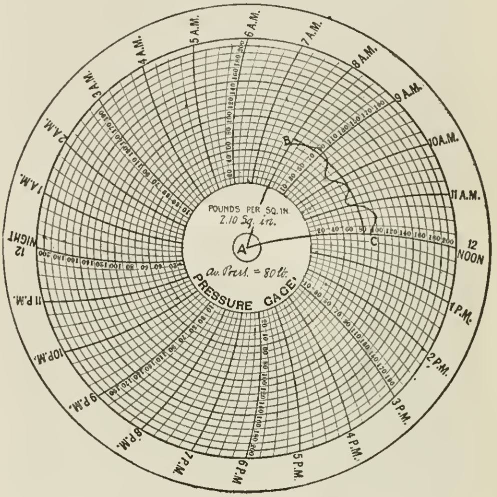


FIG. 2. COMPUTED AREA OF AN IRREGULAR 4 HOUR CHART

Decreased Frequency Caused Rotary Converter to Flash

The alternating-current characteristics of a synchronous converter are similar to those of a synchronous motor. When a rotary converter is driven from the alternating-current end, its speed will vary as the frequency of the circuit. This is also true of the synchronous motor, and the speed at all times is equal to 60 times the frequency divided by the number of pairs of poles. If the load becomes so heavy that the machine cannot run at synchronous speed, it will stop. Where the commutator end of a converter is operated in parallel with the commutator end of other converters, the machine is liable to be operated as a continuous-current motor, at a speed very likely to injure the rotor unless there is provided protective devices to prevent such a condition arising.

A synchronous converter was complained of on account of general sparking and a tendency to flash over between brush-holders or between a brush-holder and the frame of the machine. The shifting forward of the brushes one bar remedied the general sparking; this improvement in commutation decreased the frequency of the flashovers, but did not eliminate them entirely. The high-tension station from which the converter was supplied, was connected in parallel with a similar station, the two supplying the total load of the system.

Occasionally, the oil switches of one station would open and throw the whole load onto the other plant, which was located not far from the converter. The effect of suddenly imposing this abnormal load upon one station was to cause the prime movers to slow down, thereby decreasing the frequency of the current supplied to the converter. On account of the inertia of the converter's armature, its speed could not immediately respond to the sudden change of the frequency; therefore the difference between the value of the speed at which the rotor actually turned and its synchronous speed, could the rotor have instantly responded to the change in frequency, caused the machine to return energy to the supply circuit. The effect of this reversing of the functions of the machine was to so distort the flux distribution in the air gap as to place into a strong field the armature coils that were under commutation, causing severe sparking at the brush and flashovers. E. C. Parham.

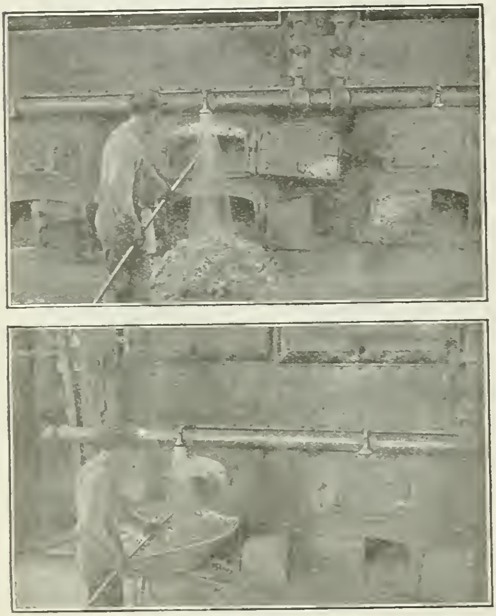
Brooklyn, N. Y.

Cleaning Boiler-Tube Plates

Referring to James M. Purcell's letter relating to cleaning boiler-tube plates, page 397 of the Sept. 2 issue of *Power*, the outfit is quite ingenious.

I have a penumatic machine and I had two extra-heavy heads made for it. One head I use on the machine when it is clamped to a bench to clean the plates; the other head I attach to a tube cleaner to clean off the face of the headers. In this way I keep two men at work with what is virtually two machines, either of which may be quickly changed to use for other purposes.

Both machines complete, one for knocking scale out of the tubes and the other for cleaning the plates, together with the extra heads, cost $110. I have used them three years, and they will stand another year before needing any repairs.



COOLING CLINKERS IN BOILER ROOMS

Ridgewood Manor, N. J. ALLAN A. BLANCHARD.

Handling Superheaters on Locomotive

I have had more experience with superheaters used in locomotive service than in stationary servie, but the same information can be well used in both cases.

In operating superheaters care should be taken not to flood the boiler with water for when the throttle is opened a certain percentage of this excess of water would be suddenly admitted into the dry pipe, superheater header, superheater units, etc., hence the sudden expansion of this water or highly saturated steam coming in sudden contact with the heated metal surfaces of superheater structure would cause more or less destruction to the superheater, by fracturing the joints of superheater units at the connection of the tubes to the cast-steel return bends, at the ends nearest the fire, and the possible loosening of the joints at the connection with the header, etc.

With locomotives in the shop with the fire out, and being hurriedly fired up, care should be taken to see that the superheater does not become flooded with the water getting too high from expansion, as this flooding would cause the water in the superheater to be rapidly generated into steam and probably cause the engine to start in case the reversing bar has not been left in the center.

In starting the locomotive care should be taken not to slip the wheels, for if the boiler is very full of water, such a rush of saturated steam through the dry pipe into the superheater will frequently cause accident to some part of superheater structure.

Tying or propping the superheater damper open should be avoided, unless it is impossible to get the engine over the road, especially when the locomotive is drifting and the blower is in operation. Even though the throttle valve is steam tight, the opening of the drifting valve may have been neglected, which would cause the threads on the superheater tubes, or inside the return bends at the ends nearest the fire to be burned. In the case where a locomotive is failing for steam, the boiler may have been filled with water preparatory to making the next grade, and when the throttle is again opened highly saturated steam is suddenly admitted into the superheater structure, which has previously been subjected to unduly high temperatures, caused by the gases of combustion passing through the flues containing the superheater units, which had neither steam nor water in them for protection against the intense heat while the damper was properly used.

Such a condition will cause serious destruction of some part of the superheater structure, and the same results will also exist when a locomotive is fired up too rapidly and the damper propped open for draft.

Steam failures are rarely attributed to defective superheater systems. Steam failures, however, may be caused directly in some cases by one defect or more frequently by a combination of defects, as follows:

Steam failures may be due to fuel containing high percentages of silica, sulphur, iron, magnesium, etc., in combination, and when subjected to high furnace temperature a slag is formed over the grate surface thereby reducing the supply of excess air necessary to complete combustion, hence a lessening of the furnace temperature and a relative drop in evaporation and steam pressure.

Defective drafting of the smoke box; poorly fitted fronts and doors, clean-out caps, loose rivets or bolts in the smoke box also tend to reduce the efficiency of the locomotive and destroy the superheater header. Defective steam pipes, exhaust tip, misaligned stack, etc., tend toward steam failures.

Leaky flues, honey-combed flue heads, flues stopped up with furnace slag, broken-down arches, valves out of square, leaky packing, bad handling of injector and poor firing tend toward steam failures.

Superheaters if treated with ordinary care and common sense are a paying investment in stationary as well as locomotive service, and can be operated in each service successfully and without danger of explosion or failure if simple rules are carried out.

Hagerstown, Md. PAUL R. DUFFEY.

Corrosion Caused by Coal-Pile Seepage

The drainage from coal piles due to the seepage of water through them is not free from dangers, as the water is, or may be corrosive. That the drainage from large coal piles in proximity to power plants must be reckoned with as a possible source of trouble is exemplified by a case of corrosion that occurred in the last fall.

Middle West company was storing about 35,000 tons of Illinois and Indiana screenings near the power house. The pile was about 18 ft. high, and covered considerable ground area. A duct line of lead-covered, paper-insulated high-potential conductors ran alongside the coal pile from the power house to substations. The coal was stored during the summer, and in the fall the heavy rains came while the weather remained warm. Shortly after the downpour of rain one of the underground cables broke down, due to dielectric failure at the manhole nearest the pile. The cable breakdown was repeated—in fact, several cables went down, all in the same manhole, which was in closest proximity to the coal pile.

Poor workmanship and dielectric strains due to test voltages are frequently the cause of the same cable breaking down repeatedly. In this instance, however, it was a different cable in each case. An investigation was started to discover a cause, if possible.

The manhole where the trouble occurred had been found full of water on the first two instances where the cable splicers had made repairs, the water level being up to the height of the cables. Samples of the water, when analyzed, showed the presence of brine, also sulphates of magnesium and iron. A strong odor of sewage and illuminating gas—common occurrences in manholes—was also noticed. The cables were supported on iron pipe embedded in the manhole walls, and a section of this pipe was also submitted to a chemist for analysis together with a section of the lead sheath of a defective cable, the section chosen embracing the splice where the cable had failed.

The cable sheath was badly corroded externally in proximity to the rupture when the cable broke down. The corrosion was not like that due to electrolysis—that is, pitted here and there—but occurred in extensive patches as if due to the water in the manholes. Moreover, it was observed that the patches along the lead seemed to correspond to a possible water level, since they appeared to occur with a fairly straight demarkation. The iron-pipe cable supports showed deposits of oxide of iron, also sulphates and sulphides of iron. The cable sleeve at the splice tested up to quantities of tin and lead sulphide with a trace of iron.

The chemist's explanation of the cable breakdowns was this: The sulphates in the manhole water came from the coal pile. Seepage from an adjacent broken sewer was responsible for the brine in the water. The sulphates aided corrosion, due to local decomposition of the salts with the free acids or brine. The weak spots in the cable splices were soon found and attacked until water entered, ultimately causing the breakdown.

The remedy suggested was either to keep the manhole free of water or to protect the cable sheaths from attack by some form of protective covering. That the manhole should be flooded after coal was stored, although it had been dry before, is probably explained by the fact that the coal pile held the water from the heavy rains, whereas it would otherwise have drained off. The coal pile acted as the equivalent of additional ground surface, and this difficulty could be solved by installing a drainage system. The cable sheaths could be easily protected by covering them with a wrapping of tape or some such binder and coating thoroughly with a suitable paint impervious to moisture and acids. The limitations of this latter practice are, of course, inability to protect the cable inside the duct ends adjacent to the manhole, and to know to what extent the covering actually covers.

The lesson of this incident seems to be that the corrosive possibilities of coal piles should be borne in mind. The seepage, if taken into boilers or condensers, might work havoc in a short time. All apparatus such as water and gas pipes, electric cables and other apparatus should be kept away from the coal pile when possible.

Chicago, Ill. R. H. Jackson.

Use of Bichromate Salts as Boiler Compound

The writer of this has been interested in the use of certain salts of chromic acid as a preventive of rusting and pitting in steam boilers. Scientific researches have shown that as long as iron remains in contact with bichromate of soda or potash even in dilute solution, rusting does not take place. The assumption is that chromic acid and its salts exercise a polarizing or dampening effect, thus preventing the solution of the iron.

It would be of interest to know whether this dampening action will hold true under high temperatures and pressures. If it will, chromic-acid salts could be used for boiler-treatment purposes where pitting or corrosion is present. Such treatment would be especially desirable where lime or soda is objectionable on account of its tendency to cause foaming in the boilers.

A few years ago the writer was engaged in tests on boiler compounds in locomotive boilers that suffered badly from pitting of flues and fireboxes. After several compounds were tried without success, it was decided to run a test with bichromate of soda. Unfortunately, conditions at that time rendered it impossible to keep the same locomotive under treatment for a period long enough to allow a reliable opinion to be formed. It can be said, however, that the water coming from the boilers when they were washed out did not have as red an appearance as before. This would indicate that corrosion was still going on, although with less intensity than without the treatment. Whether this was due to an inherent inability of the bichromate of soda to overcome or counteract corrosion altogether or merely to the manner and method in which the treatment was carried on, it is hard to decide. It may also be that positive results could be obtained only if the treatment is started in a new or perfectly clean boiler, with its interior surfaces thoroughly soaked with bichromate salts before being exposed to the corrosive action of the water.

Perhaps there are readers of *Power* who have tried these salts against corrosions in boilers and who have gathered some experience along these lines. As many plants are confronted with problems of pitting, it would be of general interest if more light could be thrown on the action of bichromates as preventives of corrosion in steam boilers. H. Bleibtren.

Philadelphia, Penn.

Meyeringh Proportional Lubricator

The descripton of the Meyeringh proportional lubricator, on page 95 of the July 15 issue of *Power*, interests me. I understand the principle involved and the object sought, and I presume that it works out all right in practice when correctly applied. Also, I can see where it may advantageously be used in pump operation, but I do not see that it is at all needed in engine operation.

I am of the opinion that the greater the volume of steam per stroke used by any given engine, as the result of increased load upon the engine, the less the quantity of oil required. A fully loaded engine using large volumes of steam per stroke is easy to lubricate as compared with underloaded engines, with an accompanying early cutoff and small steam volumes. As a general thing most engineers think that as the load is increased on an engine more internal lubrication must be supplied, but, all else being equal, the reverse is true. Therefore, it seems to me that the proportional lubricator would not really be needed for engines in which increase of load means increase of boiler steam volume per stroke.

Different operating conditions call for a particular lubricant for each individual case. If an engine is running constantly underloaded, that condition requires a certain kind of cylinder oil. If the load on that same engine is increased, so that the increase is constant, then a different kind of oil should be used if the best results are to be obtained all around. It seems to me that it would not be a case of increase of feed. That alone certainly would not meet all requirements. In an automatic engine the same surface also must be lubricated for any and all loads, for any unit period of time. But the kind of oil to use depends upon the following factors: Load, size, speed, pressure of steam and quality of steam as to whether it is wet, dry or superheated. Sometimes changing one of these factors may affect all the others, with the result that a different kind of oil should be used. If the right kind of an oil is in use, in any given engine running constantly lightly loaded, and the load is considerably increased and the increase is to be constant, then the remedy is not an increase in oil feed, but a change of oil to suit the new conditions that will prevail. Increasing the feed of the same oil used for light-load condition may perhaps do, but not so well as a grade of oil particularly suited to the conditions.

Again, if the wrong kind of oil is in use for the light-load condition, and yet suitable for the heavy-load condition, then increasing the load would not require an increased feed, for it would be likely that in order to secure proper lubrication under the light load with the wrong oil, a superabundance of oil must be used, and less of it will be required when the load condition changes to suit the oil that had been incorrectly used at first.

With proper atomization of the oil before it enters the cylinder, and with the proper kind of an oil to suit the conditions, the least quantity of oil may be used with the best results. Under heavy load conditions a greater volume of steam per stroke is used, greater volume means increased steam-flow velocity, and greater steam-flow velocity means a better atomization of oil than in the case of a light-load condition. With a full load less oil may be used than in the case of a light load, because the oil will be the better distributed and carried to all internal parts.

In the case of a steam pump that may speed up, then, an increase of lubricant is permissible, and so the proportional lubricator has a field in that direction. However, I am not undertaking to unduly criticize the lubricator in question, but simply advancing an opinion, and stand ready to be corrected if I am wrong.

Brooklyn, N. Y. CHARLES J. MASON.

Importance of Efficiency Tests

The importance of efficiency tests upon mechanical equipment cannot be too strongly impressed upon purchasers of such material, as witnessed by the following experience:

I called on one of the large Eastern pump manufacturers to make a three-hour operating test upon a 6-in. three-stage centrifugal pump, direct-connected to a 120-hp. gasoline engine. This pump was to deliver (according to specifications in my possession) 1000 gal. per min. at 1200 r.p.m. and at 230-ft. head.

The gasoline used to drive the engine was placed in a vertical tank, 12 in. in diameter and 4 ft. high. The height of the fuel was measured at the start of the run and the readings were made at the end of each hour and subtracted from the previous height. This gave the amount of fuel consumed. The amount of fuel consumed was then calculated as follows:

$$\frac{h\text{ (in inches)} \times 6 \times 6 \times 3.1416}{231}\text{ gallons.}$$

However; for every inch in a tank of 12 ft. diameter we have 0.49 gallon and therefore used this as a constant to multiply by the height observed.

The fuel consumption of the type of engine used in this test is ¾ pint per horsepower-hour or with the 120-hp. engine it should be 11¼ gal. But since actual observation showed the engine to consume 16.4 gal. per hour, I asked for an efficiency test with the following result:

Total Head	G. P. M.	B. Hp.	W. Hp.	R.P.M.	Efficiency
310.5	1000	130.8	78	1200	59.8

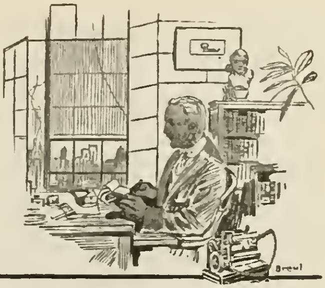
Analysis of the foregoing data will readily disclose the fact that the efficiency was low (guarantee having been 65 per cent.) enough to cause considerable increase of fuel consumption and operating cost because of the high brake horsepower or power required to operate the pump.

For continuous duty it will readily be seen that ordering a 120-hp. engine to carry a load of 130.8-hp. pump is poor engineering. No doubt these engines will operate the pump at the excessive load, but not for very long before burning the bearings and scoring the cylinders. If these outfits are for standby fire duty only, then it will make small difference as to the operating cost, and we are only concerned with the ability of the outfit to furnish water for a short period. Then again, should these pumps be required for continuous duty, it would be safer to use a 40-deg. rise motor at 10 per cent. overload, the overload in this case being but 9 per cent.

Still, would it not have been better engineering to have supplied a 150-hp. prime mover, from the standpoint of operating ability, efficiency and safety, even at the increased cost of the prime mover?

New York City. S. ROSENBERG.

INQUIRIES OF GENERAL INTEREST



Effect of Acid Feed Water on Heating Coils—What effect has acid in boiler-feed water on heating coils? B. H.

Most acids in feed waters are volatilized by heat and swept along with the steam generated in a boiler, and thus liberated in the steam their corrosiveness is intensified. When a steam-heating apparatus is supplied with steam generated from feed water containing sufficient acid impurities to be detrimental to the boiler, the corrosive effect extends to pipes, fittings, coils and radiators, and may result in troublesome leaks, especially at screwed joints.

Horsepower of Alternator—Each of the three ammeters connected in the leads of a three-phase 550-volt alternator read 80 amperes. What is the horsepower delivered at the switchboard? The alternator is rated at 145 per terminal. M. S. K.

The horsepower developed by a three-phase alternator is equal to volts × amperes × power factor × 1.732 ÷ 746. In your question you have not given the power factor. But, for example, assume that the power factor of the circuit is 0.85, then the horsepower = 550 × 80 × 0.85 × 1.732 ÷ 746 = 87 hp. The generator, when loaded to 80 amperes, is supplying only about 55 per cent. of its normal rated load.

Circumferential Cracks in Crankshafts—How can the presence and depth of circumferential cracks in crankshafts be determined and how can a cracked crankshaft be repaired? N. E. M.

To make an inspection for cracks, thoroughly clean the shaft with kerosene, and then upon wiping the surface dry the cracks will be revealed from having become filled with the oil. Their presence will be emphasized by rubbing across the cracks with chalk, red lead, or other coloring matter, afterward wiped from the surface of the shaft. The depth of a circumferential crack cannot be estimated except by removal of metal as by drilling. The only certain repair is by reforging the shaft at a welding heat, followed by very slow cooling.

Cleaning Transformers—We have three 50-kw. transformers stepping down from 2200 to 110 and 220 volts. These transformers have been in use for 13 years, but the oil has never been changed, new oil being added only to make up the losses when necessary. For a number of years these transformers operated at full load, but during the last two years they have been operating considerably under full load. However, the transformers get quite hot. I have examined the inside of the corrugations at the top and find no sediment. I have raised the covers slightly to allow the heat to escape, and this has helped considerably. Do the transformers require cleaning and new oil? How is the cleaning done? R. W. S

The temperature of the transformers as determined by the hand on the outside of the case does not mean anything as to the actual temperature of the windings and cores. As long as the temperature of the oil does not exceed 160 to 170 degrees F., it is safe to assume that the transformers are not operating at an excessive temperature. Since the transformers are 13 years old, the iron in the cores has aged considerable and they will operate at a higher temperature than when new. It is poor practice to open the covers of the transformers, since the action of the air on the warm coil tends to make it sludge, and the oil tends to take up moisture from the air, also by the moisture in the air condensing on the inside of the case and running down into the oil. The coils and cores should be removed from the tanks and thoroughly cleaned with new transformer oil. Do not use gasoline or kerosene on the coils and cores. Care should be exercised in cleaning the coils, since they have been in use for 13 years and no doubt the insulation is not very strong mechanically. Remove the old oil from the tanks and clean them thoroughly with gasoline. Replace the cores and coils in the tanks and fill with new oil. Allowance should be made for the expansion of the oils. About ⅜ in. for each foot of oil in the tank should be sufficient. The oil expands about 4 per cent. for 122 degrees F. rise in temperature.

Steam Space of Horizontal Return-Tubular Boiler—What would be the capacity of the steam space in a return-tubular boiler 72 in. in diameter by 18 ft. long with the water level 24 in. from the top of the boiler? W. N.

The cross-sectional area of the steam space can be found by the formula for determining the area of a segment of a circle, namely,

$$\textit{Area of Segment in sq. in.} = \frac{4H^2}{3}\sqrt{\frac{2R}{H}} - 0.608$$

wherein H = distances from the water level to the top part of the shell, and R = radius of the boiler. As $H = 24$ in. and $R = 72 \div 2 = 36$ in., by substituting in the formula the cross-sectional area of steam space =

$$\frac{4 \times (24)^2}{3}\sqrt{\frac{2 \times 36}{24}} - 0.608$$

= 1188 sq. in., or 1188 ÷ 144 = 8.25 sq. ft.; and having a length of 18 feet, the steam space would have a capacity of 8.25 × 18 = 148.5 cubic feet.

Horsepower of Engine Required to Develop 100 Brake Horsepower—What commercial horsepower size of steam engine would be necessary to drive machinery that requires 100 hp.? P. H. B.

The actual number of horsepower that an engine is capable of developing depends on the size of cylinder, piston speed, the mean effective pressure that can be realized, the design, strength and adjustment of parts, and the power that is lost in overcoming the friction of the engine. On account of the wide variations of these details in present-day practice, commercial ratings of engine power, based simply on the sizes of cylinder are obsolete and likely to be misleading. In establishing the power of an engine, each set of operating conditions much be considered by itself and, as the loss of power from engine friction depends largely upon the operator's attention to such details as adjustments and lubrication that are beyond control of the designer and builder, it is customary to base steam-engine power on the indicated power, or power developed on the piston, thus including the power wasted in engine friction. In average noncondensing engines suitable for developing 100 actual, or brake, horsepower, the engine friction ranges from 10 to 15 per cent., varying with the type, design, workmanship and operating conditions. If it is assumed, when handling a 100-brake horsepower load, that the friction amounts to 12 per cent., the engine would have to develop 100 × 1.12 = 112 indicated horsepower and that would be the required commercial horsepower rating of the engine for the stipulated conditions of operation.

Changes Proposed for the Third Edition National Electrical Safety Code

A TENTATIVE revision of Part I—Rules for the Installation and Maintenance of Electrical-Supply Stations and Equipment, of the National Electrical Safety Code, which, when completed, will be the third edition of this code, has been submitted by the Bureau of Standards, Washington, D. C., to its conferees on the code for consideration. In this tentative third edition no radical changes have been made. The additions are aimed to make the rules more complete. Opportunity is now offered to those interested to submit constructive criticism of the rules. The more important additions are given in the following paragraphs:

126. Motors: (a) Wiring Motors Below 750 Volts.—Motors operating at a voltage of 750 volts or less must be wired with the same precaution as required for industrial wiring carrying the same current.

(b) Protection of Wiring Over 750 Volts.—All apparatus and wiring connected to circuits over 750 volts must be completely inclosed in substantial metal shields or casings, and the conduit must enter and be properly secured to such casings or to suitable terminal boxes screwed or bolted to the casings. Shields, casings and conduits must be grounded as provided in Section 9.

The insulation of the several conductors for motors of over 750 volts, where leaving the metal sheath of cables, must be thoroughly protected from moisture and mechanical injury. This may be accomplished by means of a pothead or some equivalent method. The conduit must be substantially bonded to the metal casings of all fittings and apparatus connected to the inside circuit. Except where exposed to moisture, a metal sheath need not be provided over splices, but the end of the sheaths must be belled out and sheaths must be grounded around splices by copper wire not smaller than No. 6 A. w. g. and suitable ground clamps.

(c) Motors in Dusty Places.—Inclosed-type motors are recommended in dusty places, being preferable to wooden boxes.

(d) Drip Pans—Where practicable, motors permanently located on wooden floors must be provided with suitable drip pans.

Section 13: Storage Batteries.—Storage batteries, when used to supply current for lighting, heat or power, are subject to the same general requirements as direct-current two-wire generators.

143. Method of Transformer Installations: (a) Location.—Transformers shall be installed according to one of the following methods:

(1) On poles or (when permitted by local authority) on walls of buildings and in compliance with the overhead-line rules. (See rules 238 and 243.)

(2) In outdoor inclosures such that unauthorized persons cannot, without special effort, come in contact with any part of the casing or wiring.

(3) In transformer vaults or rooms which shall be made inaccessible to unauthorized persons. Where the amount of oil in transformer casings is considerable and the transformers are located in buildings used for other than station purposes, they should be placed in suitable transformer vaults.

(4) In rooms containing other equipment. If in stations such transformers should be well insulated from other equipment, and oil sills and suitable arrangements for draining shall be provided.

144. Apparatus with Oil.—Transformers, induction regulators and other electrical apparatus containing an appreciable amount of oil, when installed indoors shall be installed in fireproof inclosures, not having any doors or windows in such a position that burning oil could pass through them onto material or apparatus of a more or less inflammable nature. The inclosures themselves shall not contain any material or apparatus which could take fire from burning oil.

Where such apparatus is installed on a balcony or gallery above other apparatus, a gutter or other means for draining of oil or preventing it from running down on the lower floor shall be provided.

Where such apparatus is installed outdoors, adjacent walls shall be of fireproof material and shall not have any doors or windows in such a position that burning oil could pass through them onto material or apparatus of a more or less inflammable nature. Material or apparatus outdoors which could take fire from burning oil, shall not be placed within 25 ft. of the apparatus in question.

See Rule 107 (b). For requirements for oil gutter in connection with apparatus containing oil.

145. Ground Detectors: (a) Where Required.—All circuits except those as are permanently grounded as provided in Section 9, must be provided with reliable ground detectors. Detectors which indicate continuously and give an instant and permanent indication of a ground are preferable. Ground connections must be made as provided in Section 9.

(b) Electrostatic Detectors.—Electrostatic ground indicating devices shall be properly protected and be provided with a metallic shield if used on switchboards or near instruments.

150. Electrical Protection: (d) Circuits Exposed to Higher Voltages—If exposed through transformer windings, circuits below 750 volts shall be grounded unless everywhere in grounded conduit or other suitable ducts, or identified and guarded as required for conductors of the higher voltage to which they are exposed.

151. Mechanical and Thermal Protection: (d) Lead Sheathing and Potheads.—Conductors between generators and outside lines shall be in plain sight and supported on approved noncombustible, nonabsorptive insulators or placed in approved metal conduit, tile or other fireproof ducts. Conductors installed in conduit for ducts where exposed to moisture shall be sheathed and the sheathing shall be grounded. Except for systems below 300 volts to ground, the installation of the several conductors where leaving the metal sheath of cables shall be thoroughly protected from moisture and mechanical injury by means of a pothead or some equivalent method.

(e) Conductors Not in Conduit.—Conductors between generators and outside lines shall, where not in conduit, be kept so rigidly in place that they cannot come in contact. Where they pass through floors or fire walls, they shall be carried through individual openings in fire-resisting insulating tubes or their equivalent, and not through a common open space.

(f) Protection Against Excessive Temperatures.—Where insulated conductors are exposed to excessive surrounding temperatures, a special protection shall be provided if the maximum temperature exceeds the maximum safe limiting temperature adopted in the Standardization Rules of the American Institute of Electrical Engineers (Article 677).

157. Temporary Wiring and Precautions During Construction: (b) Construction Precautions.—Where extensions or extensive changes are being made to stations already in operation, the following special precautions shall be taken.

(1) All equipment and apparatus not designed for outdoor operation, but temporarily exposed to the weather or dust, dirt and flyings incident to construction, shall be especially and adequately shielded against such influence.

(2) All equipment and apparatus shall be inclosed or isolated so as to be inaccessible to unauthorized persons, or it shall be installed as required by Part 3, for equipment and apparatus accessible to unauthorized persons.

161. Location of Oil Switches: See Rule 103 for hazardous location. (a) Isolation.—Oil circuit-breakers and switches shall, wherever practicable, be isolated from other switches and electrical apparatus. On circuits over 7500 volts they must be of remote-control type and be inclosed in separate fireproof cells or compartments.

(b) Indoor Inclosures, (c) Drainage on Galleries, (d) Outdoors.—See Rule 144.

165. Where automatic cutouts are required: (a) Constant potential generators, except alternating-current machines and their exciters, and transformers or station auxiliaries, shall be protected from excessive current by suitable automatic cutouts, except as noted hereinafter and in Rule 150.

For two-wire direct-current generators, single-pole protection will be considered as satisfying the foregoing rule, provided the automatic cutout is so located or arranged as to be actuated by the entire generator's current and the action thereof will completely open the generator circuit.

(b) Generators Not Electrically Driven.—For generators not electrically driven supplying a two-wire grounded system, the automatic cutout shall be so placed as to disconnect the generator from all conductors of the circuits.

(c) Generators Used in Balancer Sets.—For two-wire direct-current generators used in conjunction with balancer sets to obtain a neutral for three-wire systems, an automatic cutout shall be installed, which in case of an excessive unbalancing of voltage will operate to disconnect the three-wire system.

(d) Three-Wire Generators.—For three-wire direct-current compound or shunt-wound generators, an automatic cutout other than a fuse shall be placed in each armature lead and so connected as to receive the entire current from the armature. The automatic cutout shall consist of either (1) a double-pole double-coil overload circuit-breaker, or (2) a four-pole circuit-breaker connected in the main and equalizer leads and tripped by means of two overload devices, one in each armature lead. These automatic cutouts shall be so interlocked that no one pole can be opened without simultaneously disconnecting both sides of the armature from the system.

(e) Motors.—Motors shall be provided with cutouts and switches as required for motors in industrial installations by Part 3.

170. Location and Accessibility of Switchboard: (a) General Location.—Switchboards shall where practicable be so placed that the operator will not be endangered by any live or moving parts of machinery or equipment located near the board. They shall be so placed as to reduce to a minimum the danger of communicating fire to adjacent combustible material.

(b) Space Above Board.—Switchboards shall be built up to the ceiling, a space of three feet being left, if possible, between the ceiling and the board. The space back of the board shall be kept clear of rubbish and shall not be used for storage.

(c) Accessibility.—Switchboards shall be accessible from all sides when the connections are made on the back (see Rule 114 for working space), but may be placed against a brick or stone wall when the wiring is entirely on the face.

184. Guarding Live Parts: (c) Insulation of Attachments.—All choke coils or other attachments inherent to lightning-protective equipment shall have an insulation from the ground or other conductors, equal at least to the insulation demanded at other points of the circuit in the station.

Water Power in New Hampshire*

New Hampshire is a mountainous and hilly district extending northwesterly from the Atlantic Coast. The total area is about nine thousand square miles, of which about one-half is forest-clad. The state is drained principally by two river basins, the Merrimac, draining the central and southern portions of the state, and the Connecticut, the northern and western. The greatest elevation in the state is about six thousand feet at Mount Washington.

Rainfall in New Hampshire averages on the whole not far from forty inches per annum. The lowest annual rainfall recorded in the state has been 22.69 in. at Hanover, N. H., in 1871, and the greatest recorded was 121.13 in. on Mount Washington in 1881 (no records available since 1886). There is a marked monthly variation of the amount of water that passes down the rivers. Melting snows of spring cause floods, and the drought of summer sees low water in the rivers. This variation of stream flow is illustrated in the records of flow in the Connecticut at Fairlee, Vt., where it is shown to have been 57,300 sec.-ft., Mar. 28, 1913, and 288 sec.-ft., Sept. 29, 1908, or about one-half of one per cent. of the 1913 flood.

Undeveloped Water Powers

The findings in regard to undeveloped water powers should be of interest and should receive careful consideration. It will be observed that on the Connecticut there are three important water-power sites from which it is estimated that 345,000,000 hp.-hr. can be secured, while on its tributaries there are five additional smaller water powers as yet undeveloped. On the Merrimac and its tributaries it is estimated that there are nine water powers with a total of 145,000,000 hp.-hr. unutilized. No suggestions are herein made as to how these should be developed, as each one must be carefully studied and a financial plan determined for each.

Main Question To Be Determined

It is not possible to state with exactness the amount of hydraulic horsepower of the state, nor is it possible to estimate closely the amount of industrial power generated by coal in plants that do not have water power, but the amount of power at the present power development that would be saved by fairly complete systems of storage would be the equivalent of about 173,000 tons of coal a year in New Hampshire and about 105,000 tons a year to users of power outside New Hampshire, a total of 278,000 tons a year, not including possibilities of the Androscoggin River.

UNDEVELOPED WATER-POWERS ON CONNECTICUT RIVER TRIBUTARIES

Power Site	Head Ft.	Drainage Area* Sq. Mi.	Flow in Cu. Ft. per Sec 50 Per Cent. Time	80 Per Cent. Time	Available Power in hp. hrs
			Estimated	Estimated	
Mascoma River Total..	140	150	150	120	9,630,000
Sugar River:			Estimated	Estimated	
Claremont	145	175	160	130	10,670,000
Chandler	55	165	150	125	3,810,000
Kelleyville	150	155	140	120	9,750,000
Total	350				24,230,000
Ashuelot River	20	430	365	150	3,080,000
Connecticut River Tributaries, Total	510				36,940,000

*Approximate.

Warren Upham, in Hitchcock's "Geology of New Hampshire," gives 3825 square miles.

DEVELOPED POWER IN NEW HAMPSHIRE

Head	Present Conditions 24-hr. hp. Low water	24-hr. hp. 60% of time	With Additional Economic Storage 24-hr. hp. Low water	24-hr. hp. 60% of time
294 ft.	42,000 hp.	47,000 hp.	47,000 hp.	52,000 hp.

UNDEVELOPED POWER IN NEW HAMPSHIRE

Head	Present Conditions 24-hr. hp. Low water	24-hr. hp. 60% of time	With Additional Economic Storage 24-hr. hp. Low water	24-hr. hp. 60% of time
268 ft.	37,400 hp.	44,180 hp.	44,180 hp.	48,800 hp.

The Connecticut River and its tributaries drain 3120 square miles in New Hampshire, which is but slightly less than the area in New Hampshire drained by the Merrimac River.

The Merrimac, which is fifth in size of New England rivers and first in New Hampshire, receives this name south from Franklin, where the Pemigewasset and Winnepesaukee Rivers unite. The total area drained by the Merrimac and its tributaries in New Hampshire is about 3820 square miles,[1] but as only a small part of the basin above Manchester has been accurately mapped, the statements of area can be regarded only as approximate, and various figures have been used by different engineers.

UNDEVELOPED WATER-POWERS ON MERRIMAC RIVER AND TRIBUTARIES

Power Site	Head, Ft.	Drainage Area, Sq. Mi.	Flow in Cu. Ft. per Sec 50 Per Cent. Time	80 Per Cent. Time	Available Power in hp. hrs
Moores Falls	25	2900	2800	1600	30,580,000
Bristol Falls	80	760	760	380	26,150,000
Smith River projects...	275	(75 to 85)	...	(60 to 70)	8,550,000
Contocook; Long Falls..	108	379	500	350	24,250,000
No. Br. Contoocook; Hillsboro	157	70	...	...	14,000,000
No. Br. Contoocook; Stoddard	200	35	...	...	8,920,000
Blackwater; Potter Place	25	39	40	20	43,000
Blackwater; Webster ...	200	122	...	...	29,150,000
Southegan; Atherton Falls	50	168	138	46	2,860,000
Total	1,120				144,890,000

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*From Report of Commission on Water Conservation and Water Power, New Hampshire.

Limits of Speed and Capacity of Steam Turbines

The Limit of a Single-Unit Turbo-Generator Lies In the Steam End and the Last Wheel Is the Limiting Factor

THE November meeting of the American Institute of Electrical Engineers was held at the Engineering Societies Building in New York on Friday evening, the 14th, under the auspices of the Committee on Power Stations, which had arranged for papers upon the limiting capacity of turbines and generators, one by Eskil Berg, of the General Electric Co., one by J. F. Johnson, and one dealing with the generator, by F. D. Newbury, both of the Westinghouse Electric and Manufacturing Company.

Mr. Johnson's paper, which was the first presented, called attention to the fact that whereas a pound of steam when entering the first stage of a turbine under ordinary conditions has a volume of less than 2½ cu. ft., when passing through the last stage it has a volume of approximately 395 ft. when expanded to 28½ in. vacuum, and 575 cu.ft. when expanded to 29 in. With the employment of high vacua the limit of power of a turbine operating at a given speed will be determined largely by the area obtainable through the last stage.

With materials of infinite strength and rigidity available, it would be possible to build units of infinite capacity; but for a given diameter and blade height the capacity will be limited by chosen maximum values of steam speed through the blades in order to keep the leaving losses, or available energy in the steam discharged to the condenser, within permissible limits. But, for a given diameter and blade height the capacity will be limited by the amount of steam that can pass through the available area between the blades, at a velocity that will not be so high as to carry away an unallowable amount of energy in the escaping steam.

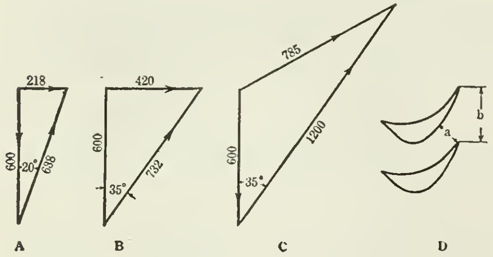


Fig. 1

FIG. 1. VELOCITY DIAGRAMS AND BLADE SPACING OF REACTION TURBINE

Throughout the reaction turbine, with the exception of the last few stages, steam speeds only about 25 per cent. in excess of the corresponding blade speeds, are employed in order to secure maximum efficiency. In the latter stages, however, the volumes become so great that a compromise between maximum theoretical efficiency and physical dimensions becomes advisable by increasing the steam speed sometimes to approximately 100 per cent. in excess of the blade speed. Higher blade speeds tend to improve the efficiency by reducing leaving losses, but generally not as effectively as would larger blade areas, with lower steam velocities and correspondingly increased number of stages.

Having fixed the height of a row of blades, the area of the steam space is dependent upon the angle formed between the center line of the row of blades and the outlet portion of the blades; that is, the space *a*, Fig. 1, D. The smaller this angle is the smaller will be the area, and vice versa. On the other hand, the smaller this angle the higher the efficiency, because of the lesser absolute velocity left in the steam discharged to the condenser. The leaving losses are in Fig. 1A, 218, Fig. 1B, 420 and Fig. 1E, 785 ft. per sec., which is the equivalent of 0.95, 3.5 and 12.3 B.t.u. per lb., respectively.

The steam area is ordinarily expressed as a ratio of the perpendicular distance between blades to the pitch of the blades; that is, the ratio of *a* to *b* in Fig. 1, D. The highest actual efficiency is obtained by keeping this ratio between 0.25 and 0.3, and this is done in all stages, except the last few, in high-vacuum machines, where it is increased to a maximum of 0.5, the equivalent angle being about 35 deg., which includes proper allowance for blade thickness. This ratio has been determined upon as a proper compromise between cost of increased blade height and loss of efficiency, due to increased terminal loss. Some European manufacturers have employed ratios as high as 0.65 and 0.7.

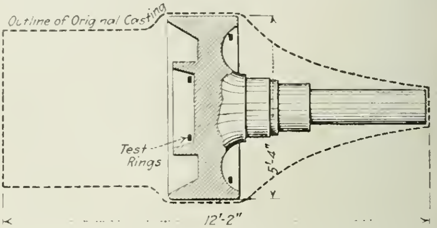


FIG. 2. STEEL CASTING FOR SPINDLE END OF DRUM TURBINE. ALL BUT THE SHADED PORTION IS DISCARDED.

While alloy steels possessing exceptionally high physical characteristics are procurable, their high qualities depend on relatively sensitive metallurgical processes, which, in the opinion of some engineers, cannot as yet be carried out by regular workmen as a manufacturing process with a sufficient degree of reliability to justify their use, and until this is done conservatism demands adherence to the lower-strength less sensitive materials. Such materials may, with suitable forms of construction, be safely stressed under the maximum test conditions to within a few thousand pounds of their true elastic limits.

When the construction of the rotor is not limited to any one special form, the design may be varied so as to take full advantage of the low speed in the high and intermediate stages (where low speed must be used in order to secure high efficiency) by employing a drum, the thickness of which may be varied to keep the stresses within desired limits; while in low-pressure stages, where the stresses are higher, either disks carried on a shaft, or solid disks suitably held together, may be employed. With the solid-disk construction the stresses may be kept within any reasonable limit up to speeds at which the design becomes too massive and expensive.

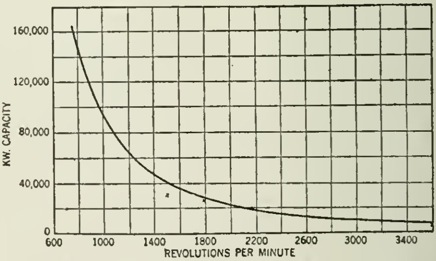


FIG. 3. LIMITS OF CAPACITY OF STEAM TURBINES WITH DOUBLE-FLOW LOW-PRESSURE STAGES

Having steel blades of uniform cross-section stressed to 25,000 lb. per sq. in. at base of blades at 20 per cent overspeed and maximum efficiency at 80 per cent of rating—250 lb. steam pressure—200 deg. superheat—29-in. vacuum referred to a 30-in. barometer—with steam velocity through blades of 1225 ft. per sec. at a volume of 585 cu. ft. per lb.

The steel regularly used by the Westinghouse company for turbine rotors has a tensible strength of 65,000 to 70,000 lb. per sq. in. elastic limits 22,000 to 25,000 lb. pr. sq. in., elongation 15 per cent. to 18 per cent., reduction of area 20 per cent. to 25 per cent., carbon 0.25, manganese 0.50 to 0.60, silicon 0.25, and not over 0.025 per cent. of sulphur or of phosphorus.

The material is obtained ordinarily in the form of castings, although occasionally as forgings. Fig. 2 shows the form of a casting for a rotor end which is cast vertically with the small end down and allowed to cool very slowly in the sand. After removal the entire upper portion, which constitutes the riser, is cut off, and the casting is then thoroughly annealed by being heated slowly and evenly to a temperature of about 1650 deg. F., and allowed to cool very slowly. It is then rough-machined to within about one-quarter inch of the finished surface, after which it is put in a furnace and heated to about 1100 deg. F. and allowed to cool slowly to remove any possible internal stress set up by reason of the material removed in machining. It is then finish-machined and given no further treatment of any kind.

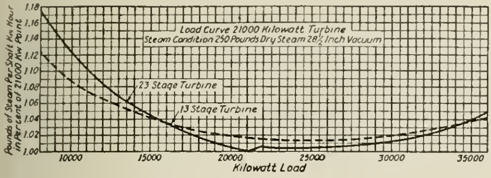


FIG. 4. LOAD CURVES OF 1800-REV. IMPULSE TURBINE WITH 13 AND 23 STAGES

The limit of stress to which this material is subjected is 20,000 lb. per sq. in. when operating at a speed 20 per cent. in excess of the normal. In a case of extreme overspeed the rotor drum, or solid disk, will stretch sufficiently to cause the blading to rub to such an extent as to practically insure its destruction and thus prevent further overspeed before the ultimate strength and elongation of the material is reached.

For any given rotative speed and blade angle the steam capacity or steam area through the blades is directly proportional to the stress at the base of the blade, regardless of the diameter and blade height selected.

This stress can be modified only by unevenly varying the cross-sectional area of the blade, as, for example, by thickening the blade near the base. Also, *for any given stress, the area through the blades will vary inversely as the square of the speed;* that is, if in a speed of 1800 r.p.m. a given stress and area are obtained, then at 900 r.p.m. the area will be increased four times if the stress is kept constant.

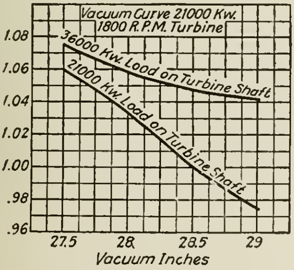


FIG. 5. CURVE OF RELATIVE STEAM RATES WITH DIFFERENT VACUA

Blading used in impulse stages and in low-pressure reaction stages in which stresses exceed 15,000 lb. per sq. in. at 20 per cent. overspeed, is made of 5 per cent. electric-furnace nickel steel, in which the carbon, sulphur and phosphorus are kept very low. It is really a nickel iron having a very fine close structure. Its physical and chemical characteristics are as follows: Tensile strength, 65,000 lb. per sq. in.; true elastic limit 35,000 lb. per sq. in.; elongation in 2 in. 30 per cent.; reduction of area, 60 per cent.; these being minimum values. Carbon, not over 0.08 per cent.; silicon, not over 0.10 per cent.; phosphorus, not over 0.025 per cent.; sulphur, not over 0.04 per cent.; manganese, not over 0.40 to 0.50 per cent.; nickel, 4.5 to 5.5 per cent.

This material is annealed by heating to 1425 deg. F. and cooled in the open air after rolling into sections required for forming into various blade shapes, and is given no further heat-treatment. The maximum stress of 20 per cent. overspeed to which this material is subject is 25,000 lb. The corresponding stress at normal speed is therefore 17,350 lb., this being 49 per cent. of the true elastic limit and 26½ per cent of the minimum ultimate strength.

For the lower-stressed reaction blading a bronze is employed consisting of copper, 97 to 98 per cent.; tin, 2 to 3 per cent.; phosphorus, 0.03 to 0.07 per cent.

Increased capacity without decrease of rotative speed, or increase of stresses, may be obtained by employing multiple low-pressure stages. This expedient possesses the merit of permitting high-vacuum turbines to be built at speeds and capacities up to approximately the present limits of generator construction, without exceeding moderate diameters, blade lengths and stresses. Fig. 3 shows approximate maximum capacities at various speeds which are physically possible, employing double-flow construction without exceeding the limits of stresses previously given. For equal capacities employing single-flow construction, the stresses would have to be doubled. The points marked x at 3600, 1800 and 1500 r.p.m. represent capacities which have already been built. This curve must not be interpreted as indicating suggested practicable present or ultimate limiting capacities of turbines, but merely as showing a physical relation between speed and capacity with given limiting stress values and operating conditions.

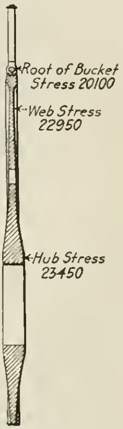


FIG. 6. SECTION OF LAST WHEEL OF 23-STAGE, 1800-R.P.M. IMPULSE TURBINE.

An important limit of size and capacity now being approached is that imposed by transportation facilities. The low-pressure rotors of the 30,000-kw. Interborough Rapid Transit Co.'s turbines were shipped with the last-stage blade-carrying elements removed.

If having given a satisfactory reliable design of a given capacity employing low stresses, it is proposed to transform it by modification of design and substitution of higher stresses into a unit of larger capacity, greater blade lengths, and probably greater blade weights, operating at higher speeds, and involving higher centrifugal forces, will be necessary in order to secure the required area. The rotor structure may possibly be shortened somewhat, but unless its total weight is increased nearly in proportion to the increase in stored energy in the individual blade, the unbalanced effect or disturbance caused by one or more blades breaking (which must be recognized as an inevitable occurrence in any turbine) will be greater, imposing greater stresses in the rotor shaft, bearings and bearing supports, and a greater factor of strength will be required to withstand these stresses. The greater blade weight and higher speed will also require increasing the mass of the casing, in order to prevent the blades from permanently injuring and possibly breaking through it if they should fail. The endurance factor of a turbine, when operating under imperfect or abnormal conditions, will be higher in proportion to the ratio of stator mass to rotor mass, and of rotor mass to blade mass. The incorporation in the design of a turbine of features which increase the endurance factor will appreciably increase its cost, but will also to a very much greater extent increase its value to the user.

As sizes become larger, a greater proportion of special equipment and processes becomes necessary, resulting in increased rates of cost, unless accompanied by very material increase in quantity of production. Under present conditions this economic limit of capacity agrees closely with the physical limit of 1500 r.p.m. units.

In the larger low-speed structures the distortions due to temperature changes, and elastic properties of the materials, are such that increased clearances and bracing have to be employed in order to maintain equal reliability and rigidity to a degree which causes the cost per kilowatt for a given efficiency to increase with increasing capacity. Further development of the allied arts and increased demand for larger units will tend to reduce the influence of this limitation factor.

Another factor tending to limit the capacity of single units is the generating capacity loss resulting from suspension of service for inspection or repairs. For example, if a 30,000-kw. unit must be kept out of service ten days for a certain inspection or repair, a 60,000-kw. unit would have to be kept out probably fourteen days for a similar purpose, because of the greater time required to handle the larger structure. Therefore, if two 30,000-kw. units were used, and each held out of service ten days, the outage loss would be only 5/7 as great as if a single 60,000-kw. unit was kept out for fourteen days.

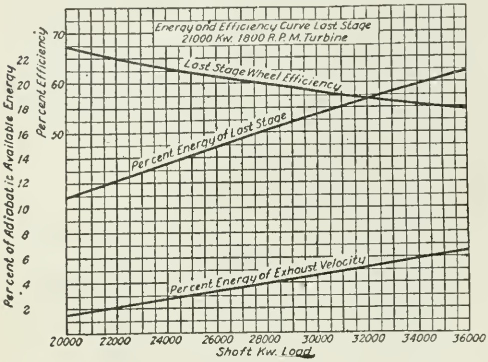


FIG. 7. ENERGY AND EFFICIENCY CURVES OF LAST STAGE

In order to avoid the limitations or undesirable characteristics just referred to, a number of turbine units of capacities varying from 30,000 to 60,000 kw. have been built, in which the turbines have been divided into two or three separate compounded elements, each driving its own generator and each capable of operating alone on high-pressure steam in emergencies.

The second paper, presented by Eskil Berg, of the General Electric Co., dealt with the present limits of speed and power of single-shaft Curtiss steam turbines. This limit does not lie in the generator, but is confined to the steam turbine, and the last wheel of the turbine is the limiting feature. The author takes the last wheel of a 1800 r.p.m. turbine, assuming dimension stresses, kind of material used, etc., and designs two turbines, one having 23 stages and the other 13 stages, the first 11 stages of the former being replaced by one two-bucket, both stages using this last wheel, and shows that a turbine can be built having its most economical point at 21,000 kw. under the assumed steam conditions.

Under the conditions of maximum efficiency the last stage absorbs 11½ per cent. of the total available energy with adiabatic expansion, and the wheel efficiency is 66.25 per cent. As the load increases, the work done in this stage also increases, so that at 36,000 kw. the energy is practically doubled, but with a sacrifice in efficiency of about 18 per cent. for the stage, which naturally lowers the efficiency of the turbine as a whole. The load curves of these turbines are shown in Fig. 4, the conditions being 250 lb. 28½ in. of vacuum of dry-saturated steam. Fig. 5 shows the effect of a change of vacuum from 27.5 to 29 in. upon the 23-stage machine at 21,000-kw. and 36,000-kw. load on the turbine shaft. The vacuum is plotted against the steam consumption, the consumption at 21,000 kw. being taken as unity.

Mr. Berg also explained the importance of area in the last wheel. Efficient action can be accomplished only by using a bucket speed that bears a proper relation to the steam velocity. Consequently, to get the largest capacity we must not only use long buckets, but must move them at a very high speed. In order to obtain good bucket action, the bucket should not be more than about one-fourth as long as the pitch diameter of the wheel. If they are made longer than this, there will be too great a difference in peripheral speed between the base and the tip of the bucket, and the flare becomes so excessive that the space between the buckets and the tip will be so large that the steam can flow between the buckets without doing any work. Fig. 6 represents the last wheel of the 23-stage 1800-r.p.m. machine. The pitch diameter is 88 in., length of bucket 22 in., and the bucket angles 60 deg. entrance and 40 deg. exit. The stresses at normal speed are given in the figure. Elastic limit of material, 55,000 lb. per sq. in. The material used in the wheel and bucket is quenched and tempered 3 per cent. nickel steel.

Cause of Wheel Breakages

In some of the first large machines of the type here discussed serious trouble has developed through the formation of cracks in the forged wheels. Such cracks have caused wheels to break in three important installations. The cracks that have formed in these wheels have started at holes in the wheels, provided either for balancing steam pressures on the two sides of the wheel or for the attachment of balance weights. The occurrence of these accidents naturally gave rise to much alarm, uncertainty and difference of opinion as to the cause of the trouble. Calculations showed that the wheels that broke were less stressed than many that were made from weaker metal and had operated for longer periods of time. Holes in a centrifugally stressed wheel greatly increased the fiber stress in the vicinity of the hole itself, but such conditions had not caused the formation of cracks in large numbers of wheels in which localized high stresses existed. Many evidences have now shown that the trouble with these wheels has not resulted from stresses in excess of those that had been previously found to be practicable, but had been caused by fluttering and vibration of the wheels, which had become possible through the lightness and thinness of their construction. Such vibration gave a periodic character to the stresses normally imposed, and so gave rise to the formation of fatigue cracks.

In machines of this type relatively light and narrow buckets have been used, and the wheels have been proportioned with a view to ample centrifugal strength, but with maximum economy of space and weight. Consequently, these wheels have had much less lateral distance than wheels used in turbines of previous types. To overcome such troubles as have developed it is necessary simply to make the wheels stiffer and to put in holes in parts of the wheel near the hub, where a suitable reinforcement of thickness can be provided which both stiffens the wheel and reduces the stresses near the hole. Very slight changes of this kind make a great difference in the vibrating characteristics of such wheels, and the proportions used are such that they can easily be brought to the same standards of safety in these respects as have long prevailed in wheels of heavier construction in machines having less numbers of stages.

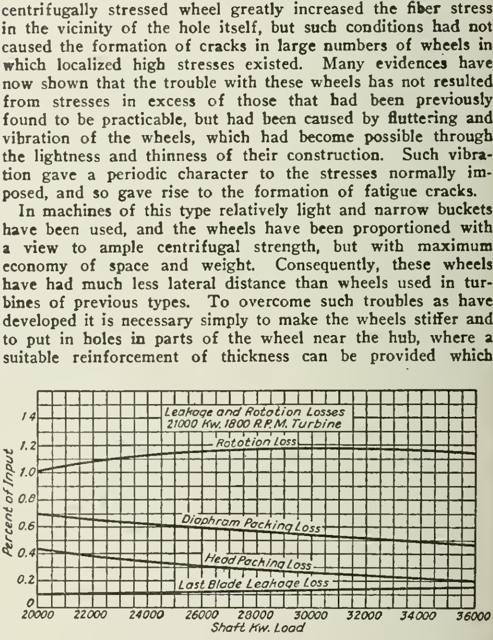


FIG. 8. LEAKAGE AND ROTATION LOSSES OF ASSUMED TURBINE IN PER CENT OF OUTPUT

Experience has shown that in the absence of a tendency to form fatigue cracks through vibration, overspeed in such turbine wheels involves relatively little danger as compared with other types of high-speed machinery. Experimentally, and in actual service, wheels have been stretched to a considerable degree of enlargement without the formation of any cracks, and such stretching is a normal condition if the cracks do not exist.

It has been discovered that such fluttering or vibration of the web of wheels has not only been responsible for the formation of fatigue cracks in the wheels themselves, but has also caused loosening and breakage of buckets. The cure for these difficulties is to use stiffer wheels, and such wheels can carry stiffer buckets, so that the whole structure is incapable of vibration of any amplitude through such forces and periods as arise from the conditions of operation.

Fig. 7 gives the energy and efficiency curves of this last stage. It will be noticed that at the most efficient point, (21,000 kw.), this stage absorbs 11.5 per cent. of the total adiabatic available energy, and that the wheel efficiency is 66.25 per cent. The energy represented by the exhaust velocity which is all wasted in the condenser is 1.5 per cent. of the total energy. As the load increases on the turbine shaft, the energy in this stage also increases, decreasing its efficiency until at 36,000 kw. the energy in the last stage is 20.9 per cent. of the total energy. The wheel efficiency, however, has been reduced to 54.2 per cent. and the energy represented by the exhaust velocity has been increased to 6.4 per cent. This great amount of work in the last stage at such poor efficiency naturally lowers the efficiency of the whole turbine, and in this case the efficiency at 36,000 kw. is 5 per cent. lower than at 21,000 kw.

Fig 8 shows leakage and rotation losses of the same turbine in percentage of input.

From the foregoing it will be seen that for 1800 r.p.m., a turbine can be designed efficiently for 21,000 kw., which, with a sacrifice of efficiency can deliver 36,000 kilowatts.

Fig. 9 gives a load curve of the smaller 3600 r.p.m. turbine. The water rates are here given in reference to that of the larger machine, the load of 5000 kw. corresponding to that of 20,000 kw. on the 1800 r.p.m. turbine. This turbine has only five stages, one two-bucket wheel in the first stage, the other four stages having single-bucket wheels. The first wheel has a pitch diameter of 35.5 in., and the remaining four wheels a pitch diameter of 51 in. The bucket height of the last wheel is 9.125 in., the turbine being designed for a maximum of 6250 kilowatts.

The reason for such a discrepancy in the number of stages calls for explanation. As the output of a turbine, keeping approximately the same stresses, goes up inversely as the square of the revolutions per minute, if the same number of stages could be used and clearance and all dimensions proportionately reduced, a 5000-kw. machine at 3600 r.p.m. could be made nearly as efficient as a 20,000-kw. machine at 1800 r.p.m., and developments of smaller multistage machines at the Lynn works have already been made which approximate such possibilities. Constructions, however, that are practicable on a large scale are not practicable on a small scale, and consequently there are difficulties in getting the space economy in small high-speed machines which would be necessary for accomplishing the result stated. One of the difficulties has lain in the construction of diaphragms, the casting in of nozzle partitions being easy in a large diaphragm and very difficult on a small one. We are working upon types of diaphragms and other parts which may make possible the development of multistage high-speed machines which afford improved degrees of economy.

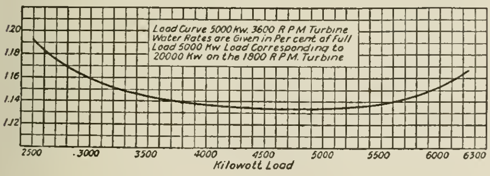


Fig. 6

FIG. 9. LOAD CURVE OF 5000-KW., 3600 R.P.M., 5-STAGE TURBINE

If a 10,000-kw. turbine is designed for 1800 r.p.m., the only change necessary would be to make the nozzle and bucket heights about half the height of those in the 20,000-kw. unit. This reduction in height of buckets and nozzles would affect the weight, size and cost of the turbine very little as compared with the 20,000-kw. unit. In regard to economy, the lower bucket heights would reduce the rotation loss somewhat but far from 50 per cent. The diaphragm packing loss, head packing losses and bearing losses would be practically the same as on the 20,000-kw. unit, so that while a turbine designed for 10,000 kw. would be more economical than the large turbine running at half load, the difference would be small, being only about 6 per cent.

It will be seen from this paper that for a given speed there is one particular size of turbine that can be designed to be most economical as to steam consumption, weight, space, and price per kilowatt. Even if a size smaller than this is required, it would in many instances pay for the central station to install the larger unit, even though it would have to run at reduced load for some time before the station load increased sufficiently to utilize the full capacity.

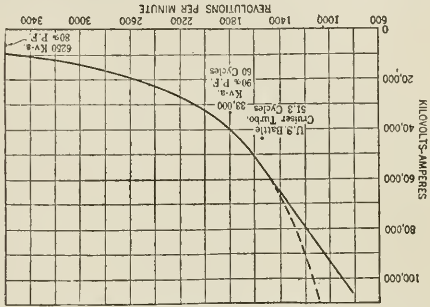


FIG. 10. CURVE OF LIMITING GENERATOR CAPACITIES AT VARIOUS SPEEDS

Mr. Newbury's paper dealt with the electrical portion of the unit. With speeds of 1200 r.p.m. and lower the stator is the limiting member, while with higher speeds the rotor is the limiting member. American design practice has established 400 ft. per sec. as an upper limit of rotor peripheral speed. The most effective rotor diameter is not necessarily the largest diameter. To obtain maximum output at a given speed, the rotor proportions must be chosen to properly balance mechanical stresses, rotor ampere turns and flux.

The maximum length of coil is determined by such factors as ventilation, bearing temperatures, critical speeds and limits to weight imposed by forging and transportion facilities. Fig. 10 shows present limits to kilowatt-ampere rating at speeds from 3600 to 900 r.p.m. These limiting values are given as indicating present boundaries to knowledge and experience, rather than as real physical or other limits that cannot be exceeded.

Mechanical forces, due to short-circuit current, and damage caused by armature winding failures, are no greater in the very large generators, indicated by Fig. 10, than in present-day 20,000 — and 30,000 — kv.a. units.

Proposed Pension Plan for Employees

Retiring employees on pensions when they have qualified by long service and reached an age when their labor is not so effective as that of younger members of the industrial ranks, was touched upon by President R. H. Ballard, of the National Electric Light Association, in his speech to the convention of the Southeastern Section held at Asheville, N. C., on Sept. 18.

By a recent action taken by the Railroad Commission, the regulating body of the State of California, Mr. Ballard said that he believed that a new principle in the jurisprudence of the United States had been enunciated. One of the largest electrical companies in that state had applied to the regulating body for authority to put into effect a pension contract granting pensions to all of its employees upon reaching the age of sixty years, after a twenty-year period of continuous service. The commission, in confirming this application, gave the pension plan the force and effect of a contract binding and collectible at law and permanent beyond the power of any future management of the corporation to eliminate and beyond the power of any future regulating body to abrogate.

Fuel-Oil Storage Rules, National Board Fire Underwriters

Individual Oil-Burning Equipments for Other Than Household Purposes

APPARATUS using oil for fuel, however safeguarded, introduces a distinct increase in hazard, which should be recognized. Where used, the following rules should be rigidly observed.

All oil used for fuel purposes under these rules shall show a flash test of not less than 150 deg. F. (Abel-Pensky flash-point tester). This flash point corresponds closely to 160 deg. F. (Tagliabue open cup tester), which may be used for rough estimations of the flash point.

Capacity and Location of Tanks

a. In closely built-up districts or within fire limits tanks to be located underground with tops of tanks not less than 3 ft. below the surface of the ground and below the level of the lowest pipe in the building to be supplied. Tanks may be permitted underneath a building if buried at least three feet below the basement floor, which is to be of concrete not less than 6 in. thick. Tank shall be set on a firm foundation and surrounded with soft earth or sand, well tamped into place. No air space shall be allowed immediately outside of tanks. Tank may have a test well, provided the test well extends to near the bottom of the tank, and the top end shall be hermetically sealed and locked except when necessarily open. When the tank is located underneath a building, the test well shall extend at least 12 ft. above the source of supply. The limit of storage permitted shall depend upon the location of the tanks with respect to the building to be supplied and adjacent buildings, as given in the following table:

TABLE I. PERMISSIBLE AGGREGATE CAPACITY IF LOWER THAN ANY FLOOR, BASEMENT CELLAR OR PIT IN ANY BUILDING WITHIN RADIUS SPECIFIED

Capacity Gallons	Radius Feet
Unlimited	50
20,000	30
5,000	20
1,500	10
*500	Less than 10

*In this case tank to be entirely incased in 6 in. of concrete.

6. When located underneath a building no tank to exceed a capacity of 9000 gal. and basement floors are to be provided with ample means of support independent of any tank or concrete casing.

c. Outside of closely built-up districts or outside of fire limits, above-ground storage tanks may be permitted as specified in Rule 1, provided drainage away from burnable property in case of breakage of tanks is arranged for or suitable dikes built around the tanks. When dikes are employed the distances specified in Table I are to be taken as distances to nearest points of dikes.

When aboveground tanks are used, all piping must be arranged so that in case of breakage of piping the oil will not be drained from tanks. This requirement prohibits the use of gravity feed from storage tanks. Aboveground tanks of less than 1000 gal. capacity without dikes may be permitted in case suitable housings for the protection of the tanks against injury are provided.

Material and Construction of Tanks

a. Tanks must be constructed of iron or steel plate of a gage depending upon the capacity as specified in the following tables:

TABLE II. UNDERGROUND TANKS INSIDE OF SPECIFIED FIRE LIMITS, OR WITHIN TEN FEET OF A BUILDING WHEN OUTSIDE SUCH LIMITS

Capacity (Gallons)	Minimum Thickness of Material
1 to 560	14 U. S. gage
561 to 1,100	12 U. S. gage
1,101 to 4,000	7 U. S. gage
4,001 to 10,500	¼-in.
10,501 to 20,000	5/16-in.
20,001 to 30,000	⅜-in.

b. All joints of tanks must be riveted and soldered, riveted and calked, welded or brazed together, or made by some equally satisfactory process. To be tight and sufficiently strong to bear without injury the most severe strains to which they are liable to be subjected in practice. The shells of tanks to be properly reinforced where connections are made, and all connections should as far as practicable be made through the upper side of tanks above oil level.

TABLE III. UNDERGROUND TANKS OUTSIDE OF SPECIFIED FIRE LIMITS, PROVIDED THE TANKS ARE TEN FEET OR MORE FROM A BUILDING

Capacity (Gallons)	Minimum Thickness of Material
1 to 30	18 U. S. gage
31 to 350	16 U. S. gage
351 to 1,100	14 U. S. gage
1,101 to 4,000	7 U. S. gage
4,001 to 10,500	¼-in.
10,501 to 20,000	5/16-in.
20,001 to 30,000	⅜-in.

c. Tanks shall be thoroughly coated on the outside with tar, asphaltum or other suitable rust-resisting material.

Note: The protection required for tanks will depend on the condition of the soil in which they are installed. When the soil is impregnated with corrosive materials, tanks should be made of heavier metal in addition to being protected as specified above.

Fill and Vent Pipes

a. Each underground storake tank having a capacity of over 1000 gal. to be provided with at least 1-in. vent pipe extending from the top of the tank to a point outside of building. Vent pipe to terminate at a point at least 12 ft. above the level of the top of the highest tank car or other reservoir from which the storage tank may be filled. Terminal to be provided with a hood or gooseneck protected by a noncorrodible screen and to be located remote from fire escapes and never nearer than 3 ft., measured horizontally and vertically, from any window or other opening. Vent pipes from two or more tanks may be connected to one upright, provided the connection is made at a point at least one foot above level of source of supply.

b. Tanks having a capacity of less than 1000 gal. may be provided with combined fill and vent pipes so arranged that the fill pipe cannot be opened without opening the vent pipe, these pipes to terminate in a metal box or casing provided with a lock.

c. Fill pipes for tanks which are installed with permanently open vent pipes must be provided with metal covers or boxes which are to be kept locked except during filling operations.

d. Fill and vent pipes for tanks located under buildings are to be run underneath the concrete floor outside of building.

Indicator

Some device for indicating the level of the oil is desirable. Where used, such attachment shall be connected through substantial fittings so as to minimize exposure of the oil, and devices the breakage of which will allow the escape of oil must not be used.

Filters

Suitable filters or strainers for the oil should be installed and preferably located in the supply line before reaching the pump. Filter to be arranged so as to be readily accessible for cleaning.

Feed Pumps

a. Must be of approved design, secure against leaks.

Note: Stuffing-box, if used, should be provided with a removable cupped gland designed to compress the packing against the shaft and arranged so as to facilitate removal. Packing affected by the oil must not be used.

b. To be arranged so that dangerous pressures will not be obtained in any part of system, and it is further recommended that feed pumps be interconnected with pressure air supply to burners to prevent flooding.

Gage Classes and Pet-Cocks

Glass gages, the breakage of which would allow the escape of oil, are to be avoided. If their use is necessary, they should have substantial protection or be arranged so that oil will not escape if broken. Pet-cocks must not be used on oil-carrying parts or system.

Receivers or Accumulators

a. If used, they must be designed so as to secure a factor of safety of not less than 6. Must be subjected to a pressure test of not less than twice the working pressure.

b. The capacity of the oil chamber must not exceed 10 gal.

c. To be equipped with pressure gage.

d. To be provided with an automatic relief valve set to operate at a safe pressure and connected by an overflow pipe to supply tank, and so arranged that the oil will automatically drain back to the supply tank immediately on closing down the pump.

Standpipes

a. If used, their capacity shall not exceed 10 gal.

b. To be of substantial construction equipped with an overflow, and so arranged that the oil will automatically drain back to the supply tank on shutting down pump, leaving not over one gallon, where necessary, for priming, etc.

c. If vented, the opening should be at the top and may be connected with the outside vent pipe from storage tank, above level of source of supply.

Piping

a. Standard full-weight wrought iron, steel or brass pipe with substantial fittings to be used and to be carefully protected against injury. Piping under pressure must be designed to secure a factor of safety of not less than 6, and installation to be tested to a pressure not less than twice the working pressure.

b. Piping to be run as directly as possible, and laid so that the pipes are pitched toward the supply tanks without traps.

c. Overflow and return pipes to be at least one size larger than the supply pipes, and no pipe to be less than ½-in. pipe size.

d. All connections to be perfectly tight with well-fitted joints. Unions, if used, to be of approveed type having at least one face of the joint made of brass and having conically faced seats, obviating the use of packing gaskets.

e. Pipes leading to the surface of the ground to be cased or jacketed where necessary to prevent loosening or breakage, and proper allowance should be made for expansion and contraction, jarring and vibration.

f. Connections to outside tangs to be laid below the frost line and not to be located near nor placed in same trench with other piping.

g. Openings for pipes through outside walls to be cemented and made oil-tight.

Valves, Etc.

a. Readily accessible shutoff valves to be provided in the supply line as near to the tank as practicable and additional shutoffs to be installed in the main line inside building and at each oil-consuming device.

b. Controlling valves in which oil under pressure is in contact with the stem to be provided with stuffing-box of liberal size, containing a removable cupped gland designed to compress the packing against the valve stem and arranged so as to facilitate removal. Packing affected by the oil must not be used.

c. The use of approved automatic shutoffs for the oil supply in case of breakage of pipes or excessive leakage in building is recommended.

Henry C. E. Meyer gave an interesting paper on "The Application of Standardization and Graphical Methods to the Design of Cylindrical Return Tubular Boilers," before the recent meeting of the Society of Naval Architects and Marine Engineers, 29 W. 39th St., New York City. The design relates to Scotch boilers, those with separate and those with common combustion chambers. There is a scarcity of published data on performance of these boilers, and Mr. Meyer gives as guide performances during voyages of a tramp steamer.

Trade Unionism as Viewed by The American Association of Engineers

The American Association of Engineers, through its board of directors, recognizing the many fundamental differences between the principles and objectives of the trade union and of an organization of professional men, expresses the opinion that an engineer cannot subscribe to the tenets of both. The position of the association is defined in the following paragraphs:

The engineer is the medium through which both capital and labor are used in production and in industrial development. The aim of the profession is to advance civilization and render the highest service to society. Except when their acts further this aim, it is an advocate of neither capital nor labor.

Production should be increased—not limited. The profession cannot support strikes or lockouts or any other method that may benefit any class at the expense of the nation as a whole. They are unsound and must inevitably lead to economic disaster. The law for supply and demand for men or material must ultimately prevail. Attempts may be made to limit the supply of either, but looking toward the upbuilding of civilization we believe rather in increasing the demand through the promotion of legitimate enterprises.

Rewards should be according to ability, initiative and constructive effort. Men are not equal in these respects. Each man should be encouraged to do his utmost and be given compensation according to ability and will to increase production and to achieve large results.

The engineer, as an educated professional man, believes in basing his claims for proper and just reward for his services upon the justice of the facts presented, upon enlightenment of public opinion, upon loyalty between employer and employe, and upon the underlying fundamental desire of the great majority to do what is fair and right when the merits of the case in question are clearly presented and demonstrated. The board believed in organized representation for the correction of wrong, the advancement of the profession and service to the public, but were opposed to methods inconsistent with the dignity of the profession and which would lesson public confidence.

The Dinner Is Being Ruined

WELL MY LAND! COULDN'T YOU FETCH A BUCKET OF COAL AND DECIDE THAT GAME AFTERWARDS ?
PUBLIC
OPERATORS
INDUSTRIES
WAGE QUESTION
MINERS
(Copyright, 1919, New York Tribune
Ding

Fiftieth Anniversary Dinner W. S. E.

On the evening of Dec. 2 at the Morrison Hotel, Chicago, the Western Society of Engineers held its fiftieth anniversary dinner and reunion. The banquet was a record breaker, over 600 sitting at the tables. A goodly proportion were of the new members obtained in the recent drive, and they in particular were greeted and made welcome by President Baldwin, acting as toastmaster. Incidental to the program Secretary Nethercut made the interesting announcement of a fund of $5000 offered by R. W. Hunt, the income of which at 5 per cent. was to be set aside as a yearly prize for the best paper presented to the Society on subjects relating to the manufacture of iron or steel.

E. M. Hughman, honorary secretary of the Indian Society of Engineers, was in attendance and made a few extemporary remarks concerning the recent consolidation of engineers in India into the above named association. The new movement resembles that of the American Association of Engineers in this country. Of a prospect list of 10,000 they now have 35 per cent.

R. E. Patterson Kline gave the address of the evening on "Who Owns Your Business?" dealing with the present troublesome times, and the rights of private property which temporarily were being submerged. The old ideas of 1914 concerning individualism were gone forever. In the present period of fluidity the pendulum was swinging in the opposite direction. The existing problems should be viewed in the light of history, and tempered, sane propaganda should be given the earliest and widest distribution possible to combat the radical movement. Capital, brawn and brains, the three big factors needed in industry, each had a place, and for the best interests of all mere brawn cannot dominate.

Throughout the dinner the Universal Quartette rendered numerous selections and led community singing. A series of vaudeville acts closed the entertainment of the evening.

Accidents to Two Turbines

A 3000-kw. horizontal Curtis turbine installed in the plant of the Connecticut Light & Power Co., Waterbury, Conn., eight years ago, completely wrecked itself at 1:15 p. m., Nov. 18, killing two men, injuring others, and doing damage to other turbines and the power house building. The machine ran at 1800 r.p.m. and had a rim speed of about 400 ft. per sec., which is much lower than velocities which are safely carried upon modern machines by the same builders.

Some of the wheels were split apart, others are badly battered and broken at their peripheries; the shaft was broken and the bolts in the coupling bent. The turbine end of the shaft was hurled upward, just clearing the adjacent turbine, but bending the lifting bolts in the top of its casing; the broken shaft continued on, striking and bending the crane rail and landing outside the turbine room. Exclusive of the generator stator and rotor the heaviest piece of broken metal probably does not weighs more than 500 lb.

Viewing the wreck and the turbine room it seems remarkable that the severe damage was confined to one machine. This turbine was one of six, all set transverse of the room; it was number three, thus having two machines to the north and three to the south of it. The building walls and roof, the latter of 5-in. thick reinforced concrete, are perforated in numerous places where chunks of metal burst through. The engineer's office, which is at the south end of the turbine room, was damaged, pieces of metal breaking through the wall and door. Fortunately no one was in the office at the time. An oiler standing on an elevation near the power house was looking in the direction of the plant when the machine let go. He saw several large pieces of it burst through the concrete roof and land into the river nearby. One piece of metal, said to weigh about 500 lb., was hurled through the building and continued on some three or four hundred yards into the second story window of the nearby brass works.

News comes to us also of the failure of a 4000-kw., 6-stage, 1800 r.p.m. unit at the Ashley Street Station of the Union Electric Light & Power Co., at St. Louis. This was installed in 1911 and was the second of the horizontal type put out.

Investigations of both accidents are under way and we hope to print further particulars as to their cause.

Coal Crisis Now Confronting Chicago and Northwest

As this issue goes to press the coal situation in Chicago and the Northwest has reached a critical stage. This section of the country depends almost entirely on bituminous coal, and therefore is hit hardest by the coal strike.

At present the soft-coal production is only 600,000 tons daily, as compared with a normal production of over 1,800,000 tons. Almost half the total production is by non-union labor, but this is in fields far removed from the Middle West, and so far little of this coal has been diverted to the districts in greatest need, due partly to lack of cars. In fact, at present only 20 per cent. of the normal supply is being received in Chicago, and from the latest reports there are available only 8000 carloads to take care of a population of 30,000,000 people in the Northwest.

According to Samuel Insull, president of the Commonwealth Edison Co., and representing the subsidiary public utility companies of Illinois, there is on hand at the plants of the Commonwealth Edison Co. less than 25 days' supply of coal. This makes a large reduction in consumption of electricity imperative.

The committee appointed by the Public Utilities Commission to investigate the situation has recommended the following drastic regulations:

1. All unnecessary interior and exterior electric lights, including show windows, signs, etc., be stopped.

2. Suburban and local transportation reduced to the least number of runs to accommodate traffic requirements, reducing heat also.

3. Work shops, industrial establishments, wholesale business, mercantile establishments, storage warehouses (cold storage excepted) to be open not more than from 8 a. m. to 3:30 p. m.

4. Loop retail establishments to be open from 11 a. m. to 5:30 p. m., 6½ hours; outlying retail stores to be open from 12 noon to 6:30 p. m.

5. Office buildings, banks, etc., to be open from 9 a. m. to 3:30 p. m. only.

6. Limit theaters to six performances a week, excepting moving picture houses.

It is predicted that unless the situation improves within the next few days still greater restrictions will be forthcoming.

Mr. F. S. Peabody, president of the Peabody Coal Company, voicing the opinion of operators, believes that the time has come for the Government to maintain a position of "hands off" and allow the matter to be adjusted between the operators and the miners with a view to getting production established, even though it does mean paying the miners a higher wage than the Government has stood for. Mr. Peabody pointed out that it is impossible to replace the striking miners in the Illinois field on account of a law which prescribes that no miners shall work without two years' previous experience. The miners in these fields in 1914 received 61 cents per ton of coal mined. They are now receiving 85 cents per ton, and if the recommendation of a 14 per cent. increase, as urged by Mr Garfield, are adopted, this would raise the rate to 95 cents per ton mined. According to Mr. Peabody an able-bodied miner can turn out 20 tons a day, bringing his daily wage up to something like $18. Statistics for the past year show that in one of the large coal companies in this district employing about 20,000 men, there were on an average of 1800 voluntarily idle at all times.

Mr. Charles Piez, formerly chairman of the U. S. Shipping Board, and now chairman of the Chicago Coal Committee, disagrees with Mr. Peabody, and maintains that the Illinois law which puts the coal situation into the hands of organized labor should be repealed at once; that the federal and state governments should coöperate, and that the matter is not one for the operators and the miners to adjust between themselves and pass the burden on to the consumer, but that it is purely a question for the people to take into their own hands, through the agencies of the Government, and that all individual interests should be subordinated to the public welfare.

New Publications

GOVERNORS AND THE GOVERNING OF PRIME MOVERS. By W. Trinks, M. E., Professor Mechanical Engineering, Carnegie Institute of Technology. Published by D. VanNostrand Co., New York. Cloth, 6 x 9 in.; xviii + 236 pages.

This book aims to supply a knowledge of the fundamental principles of governors in a form available to designing and operating engineers. A discussion of the theory of governors leads to considerable mathematics, but in an appendix the author has given elementary derivations of those parts which, as given in the text, require a knowledge of higher mathematics. There are a number of illustrations, all of which, however, are in the form of diagrams, as it is no part of the author's plan to discuss actual forms and details, but rather to present fundamentals. There is a short historical sketch, followed by a discussion of the action of governors alone, and later a discussion of the reaction between the governor and the prime mover. There is also a chapter on governor troubles and their remedies. A bibliography containing 83 titles is added for the convenience of those who wish to study the subject more completely.

STEAM TURBINES. By James Ambrose Moyer. Fourth edition. Published by John Wiley & Sons, New York City. Cloth, 9 x 6 in.; 406 pages.

The chief additions to this volume embodied in the fourth edition are those that relate to methods of governing the calculation of the strength of disk type of blade wheels, and the recent developments in marine practice. There are, of course, many other changes and additions to other chapters. This book is too well known to require lengthy review here. The fourth edition heightens the high standard of this book.

PRACTICAL MATHEMATICS FOR HOME STUDY. By Claude Irwin Palmer, Associate Professor of Mathematics, Armour Institute of Technology. Published by McGraw-Hill Book Co., Inc., New York. Flexible cloth, 5 x 8 in.; 493 pages.

The purpose of this volume is to supply a textbook of mathematics for use in classes of adults engaged in practical work, as well as a guide for the man who is studying mathematics by himself. There are four parts, devoted to arithmetic, geometry, algebra and trigonometry. No attempt is made to treat any subject exhaustively, but enough explanation is given to enable the man who is unfamiliar with mathematics to obtain a working knowledge sufficient for the solution of the problems confronting the practical worker. The author has succeeded in covering a large field very clearly and yet in compact form. A feature of the work is the large number of exercises or problems supplied.

AMONG INDUSTRIAL WORKERS. Published by the Industrial Department of the International Committee Young Men's Christian Association, New York. Cloth, 6 x 9 in.; 175 pages.

This is a handbook of Young Men's Christian Association work in industrial fields. The book, which contains 22 chapters, deals with the Association's relation to industry, both employers and employees, takes up the cooperation with other agencies, special groups of industrial workers, Americanization, the religious program in industry, social activities, showing how work of this kind may be carried on by the Association. Chapter 18 deals with the suggested industrial policies for state committees. The book embodies the experience of the Association which, as everyone knows, has been wide. It would seem that the book is a necessity to any industrial Y. M. C. A. secretary, and those who are carrying on industrial welfare work will find the book of material aid.

THE GASOLINE AUTOMOBILE. By Hobbs, Elliott and Consoliver. Published by McGraw-Hill Book Co., Inc., New York. Cloth, 6 x 9; 483 pages.

This is a second edition of a book under the same title by George W. Hobbs and Ben G. Elliot. The present edition has been completely revised and rewritten by Ben G. Elliot and Earl L. Consoliver, professor and assistant professor, respectively, of mechanical engineering, University of Wisconsin. The purpose of the book is to enable the average automobile owner to understand the mechanical principles underlying the operation of his car. This second edition has been prepared to keep in touch with the developments in automobile practice. Six chapters have been added and many new illustrations are included. No attempt has been made to cover all makes and models of cars, but the idea of giving instruction in fundamental principles has been followed.

Personals

William Tietze has resigned as chief engineer of Cudahy Bros. Co., to assume the position of manager of the Citizens Light, Heat and Power Co., Canby, Minn.

Harry Himelblau announces the initiation of a consulting engineering practice, in addition to his duties as mechanical engineer with the Armour Grain Co., in the company's offices at 208 So. La Salle St., Chicago.

Harry J. Lindsley and **William F. Jennings** have been made vice presidents of the Bound Brook Oil-Less Bearing Co., of Bound Brook, N. J., in recognition of their services to the company. Mr. Lindsley has been western sales manager for the last seven years and Mr. Jennings eastern sales manager for the last five years.

John W. Price, for a number of years chief engineer of Haddon Hall, Atlantic City, N. J., and a past president of Atlantic Council No. 4 of the American Order of Steam Engineers, has been appointed a member of the State Examining Board of Steam Engineers of the state of New Jersey.

Frank G. Phegley, who has been manager of the Cleveland office of Warren Webster & Co. for nine years, has resigned to enter the professional field as consulting engineer in heating and ventilating work. Clyde W. Colby has been appointed to succeed him assisted by William Roebuck, Jr., of the home office sales engineering force.

Herbert J. Flagg, formerly captain of coast artillery, has been appointed chief engineer of the Public Service Commission of Washington, with headquarters at Olympia, to succeed D. F. McCurrach, resigned. Captain Flagg has been on the engineering staff of the commission since 1915.

Dugald C. Jackson and **Edward L. Moreland** announce that after their absence in France in the Corps of Engineers, United States Army, they have now resumed their practice as consulting engineers under the firm name of Jackson & Moreland with offices at 387 Washington St., Boston, Mass. Arthur L. Nelson has become associated with the firm for the purpose of giving particular attention to the design and the supervision of construction of power plants and transmission systems.

New Construction

PROPOSED WORK

Mich., Highland Park (Detroit P. O.)—The Hamilton Theatre Co., c/o C. Howard Crane, Arch., Huron Bldg., Detroit, plans to build a 3 story, 68 x 170 ft. theatre and office building on Highland Ave. A complete steam heating system will be installed in same. Total estimated cost, $300,000.

Mich., Highland Park (Detroit P. O.)—John H. Kunsky, Inc., 501-520 Madison Theatre Bldg., retained C. Howard Crane and E. G. Kiehler, Arch., Huron Bldg., to prepare plans for the construction of a 2 story, 100 x 180 ft. theatre on Hamilton Blvd. A steam heating and ventilating system will be installed in same. Total estimated cost, $250,000.

Mich., Highland Park (Detroit P. O.)—The Tuxedo Theatre Co., c/o L. W. Lehmkuhle, 1254 Philadelphia Ave., Detroit, plans to construct a 2 story, 135 x 140 ft. theatre on Hamilton Blvd. A steam heating and forced ventilation system will be installed in same. Total estimated cost, $200,000.

Mich., Niles—The city retained C. W. Hubbell, Engr., 2348 Penobscot Bldg., Detroit, to prepare plans and estimates for a water system. Work will include sinking wells, laying new pipe mains and installing motor driven centrifugal pumping units. Total estimated cost, $75,000.

Mich., Owosso—The city is having plans prepared by H. Riggs, Engr., Engineering Bldg., Ann Arbor, for the installation of a steam pumping unit, having a capacity of 3 to 5,000,000 gallons per day, also an electric driven air compressor having a capacity of 1200 cu. ft. per minute.

Mich., Strathmoor—School District No. 4, c/o H. T. Hart, P. O. Box 84, retained W. H. Adams, Engr., Vinton Bldg., Detroit, and Butterfield & Butterfield, Arch., 1113 David Whitney Bldg., Detroit, to prepare plans for the construction of a 2 story school. A steam heating system will be installed in same. Total estimated cost, $100,000.

Minn., Chisholm—J. P. Vaughan, Supt. of the Board of Education, will receive bids until January 2 for the construction of a 2 story, 68 x 147 ft. grade school. A steam heating and ventilating system will be installed in same. Total estimated cost, $225,000. W. T. Bray, Torrey Bldg., Duluth, Arch. and Engr.

Minn., Duluth—G. Phillips, Comr. of the Duluth Water Light Dept., will receive bids about January 15 for the construction of a 3 story, 50 x 140 ft. office addition on West 1st St. A steam heating system will be installed in same. Total estimated cost, $150,000.

Minn., Minneapolis—The Industrial Investment Co., 807 Hennepin Ave., is having plans prepared for the construction of a 12 story, 200 x 230 ft. theatre and office building on 8th St. and Hennepin Ave. A steam heating system will be installed in same. Total estimated cost, $400,000. J. E. D. Pridmore, 38 South Dearborn St., Chicago, Arch.

N. Y., Charlotte—The Rochester Folding Box Co. plans to construct an addition to its plant on Elizabeth Ave., here. Additional transmission and box making machinery will be installed in same. Total estimated cost, $300,000. E. Z. Adams, Pres.

N. Y., Elba—Wheat's Ice Cream Co., 235 Elm St., Buffalo, has purchased the plant of Flanders Co., here, and plans to alter and install new plant machinery and equipment in same. About $250,000.

N. Y., Long Island City—E. L. Walsh, Superintendent of Public Works, Capitol, Albany, will soon award the contract for installing electric wiring and lighting, power and battery charging equipment for the Barge Canal Terminal at the foot of North Jane St., here.

N. Y., Long Island City—Ballinger & Perrott, Arch., 47 West 34th St., New York City, will soon award the contract for the construction of a 10 story factory on Queens St., for W. P. White, c/o Architects. A steam heating system will be installed in same. Total estimated cost, $1,000,000.

N. Y., New York—The 22 East 70th St. Corporation, 52 William St., will build a 12 story hotel at 22 East 70th St. A steam heating system will be installed in same. Total estimated cost, $400,000 Work will be done by day labor.

N. Y., New York—J. Tishman & Sons, 18 East 41st St., will build a 16 story showroom and office building at 19 West 37th St. A steam heating system will be installed in same. Total estimated cost, $1,200,000. Work will be done by day labor.

N. Y., New York—Charles Steiner, c/o New 14th St. Theatre, 235 East 14th St., plans to build a theatre on 2nd Ave. and 9th St. A steam heating system will be installed in same. Total estimated cost, $300,000. Work will be done by day labor.

N. Y., New York—The Isbrandsen Moller Co., Woolworth Bldg., is in the market for motors, motor trucks and elevators, etc., for altering Piers 12 and 13, which they rented from the city for their own use.

N. Y., New York—The Federal Reserve Bank, 15 Nassau St., is having plans prepared for the construction of a bank building on Maiden Lane, Nassau, Liberty and William St. A steam heating system will be installed in same. Total estimated cost, $2,500,000. York & Sawyer, 50 East 41st St., Arch. and Engr.

N. Y., Rochester—The Allen Woolen Mills plans to construct a boiler plant in connection with proposed factory, on Elton and Russel St. Estimated cost, $25,000 Atkinson Allen, Pres.

Ohio, Cincinnati—The Columbia Amusement Co., 7th Ave. and 47th St., New York City, plans to build a theatre on 7th St. near Main St. A steam heating system will be installed in same. Total estimated cost, $400,000.

Ohio, Cleveland—The Ultimate Tire & Rubber Co., Hippodrome Bldg., will soon award the contract for the construction of a 3 story, 80 x 262 ft. rubber tire factory on East 152nd St. Boilers will be installed in same. Total estimated cost, $200,000. R. J. Birch, Pres. and Gen. Mgr. W. S. Ferguson, 1900 Euclid Bldg., Arch. W. F. Ridge, Ohio Bldg., Akron, Engr.

Ohio, Cleveland—E. S. Root, Arch., 1513 University Rd., is receiving bids for the construction of a 2 story, 55 x 58 ft. power house for the Ohio Machine & Boiler Co., 1501 University Rd. A steam heating system will be installed in same. Total estimated cost, $15,000.

Ohio, Cleveland—M. Rabinowitz, 2532 East 22nd St., will soon award the contract for the construction of a 2 story, 40 x 70 ft. warehouse and cold storage plant on 22nd St. Estimated cost, $60,000. Allen Sogg, 319 Hippodrome Bldg., Arch.

Ohio, Cleveland—The Mid West Box Co., 111 West Washington St., Chicago, has plans prepared for the construction of a 3 story, 98 x 402 ft. box factory and power house on West 106th St. and Western Ave., here. A complete power plant will be installed in same. Total estimated cost, $300,000. DeVore Co., 908 Nicholas Bldg., Toledo, Arch. and Engr.

Ohio, Cleveland — The Green Haas Schwartz Co., East 55th St., near Superior Ave., plans to build a 3 story, 164 x 290 ft. factory, boiler house and office building on 105th St. and Elk Ave. Plans include a complete electric plant, consisting of 2 boilers, stokers, condensers, pumps, oil separators and feed water heaters. Total estimated cost, $500,000. Christian, Swarzenberger & Gaeda Co., 1900 Euclid Bldg., Arch.

Ohio, Cleveland—The Gordon Square Co., West 65th St. and Detroit Ave., has purchased a site and plans to construct a 3 story, 150 x 225 x 267 ft. theatre, store, and market house. Two 250 h.p. boilers and valves will be installed in same. Total estimated cost, $700,000. W. G. Caldwell, 1206 Williamson Bldg., Arch.

Ohio, Cleveland—The Citizens Savings & Union Commerce, National Bank Bldg., is having plans prepared for the construction of a 20 story, 258 x 383 ft. bank and office building on Euclid Ave. and 95th St. A complete power plant, consisting of three or four 300 h.p. boilers, stokers, high speed engine, two generators and twelve to twenty 250 h.p. kw. motors will be installed in same. Total estimated cost, $8,000,000. Graham, White, Anderson & Probst, Railway Exchange Bldg., Arch. and Engr.

Ohio, Willoughby—The Zenith Tire & Rubber Co., 456 Leader News Bldg., Cleveland, has had plans prepared for the construction of a 1 and 3 story, 100 x 585 ft. rubber factory and power plant. Total estimated cost, $500,000. A. W. Harris, 829 Schofield Bldg., Cleveland, Arch. and Engr.

Okla., Duncan—Stephens County plans to construct a 4 story, 70 x 80 ft. court house. A steam heating system will be installed in same. Total estimated cost, $150,000. Jewel Hicks, Oklahoma City, Arch.

Okla., Muskogee—The Board of Education will soon award the contract for the construction of two 1 story ward schools. A steam heating system will be installed in same. Total estimated cost, $200,000. C. W. Dawson, 207 Barnes Bldg., Arch.

Okla., Oklahoma City—The Board of Education will soon award the contract for installing heating and ventilating systems in the proposed Webster Junior High School, 11th and Lindsey St.; Classen Junior High School, 17-19 Ellis St., and the Capitol Hill High School, Capitol Hill Addition. J. G. Stearley, 400 North Walnut St., Clk.

Okla., Oklahoma City—The Oklahoma Club will receive bids about January 1 for the construction of a 12 story, 125 x 140 ft. club building. A steam heating system will be installed in same. Total estimated cost, $750,000. Hawk & Parr, 501 Security Bldg., Arch.

Okla., Oklahoma—The Scottish Rites Consistery, Guthrie, plans to construct a 3 story cathedral on the old capitol grounds, here. Plans include refrigerating, heating, ventilating, light and power systems. Total estimated cost, $3,000,000. Hawk & Parr, 501 Security Bldg., Arch.

Okla., Tonkawa—The city sold $15,000 bonds to improve its electric system. Johnson & Benham, Firestone Bldg., Kansas City, Mo., Consult. Engr.

Tex., McKinney—The McKinney Ice & Coal Co. plans to improve its 50 x 60 x 60 ft. ice storage plant, and will be in the market for motor driven refrigerating equipment. Total estimated cost, $300,000. Thomas E. Craig, Mgr.

Tex., Wichita Falls—The Wichita Falls Electric Co. will enlarge its central power station here, and extend its transmission lines to a number of cities and towns. Estimated cost, $1,000,000.

Wis., Milwaukee—The Milwaukee Reliance Boiler Works, 1102 32nd St., plans to construct a 1 story, 70 x 180 ft. boiler plant on 32nd St. Armand D. Koch, Wells Bldg., Arch. and Engr.

Wis., Sheboygan—Cahill & Douglas, Engr., Gross Bldg., Milwaukee, will soon award the contract for the construction of a generating unit, including a 75-100 h.p. D.C. uniflo engine unit, for the Phoenix Chair Co., here.

Wis., South Milwaukee—The Universal Aniline Dyes & Chemical Co., 1009 Wells Bldg., Milwaukee, has purchased site and plans to build a 1, 2 and 3 story manufacturing plant, including a 1 story, 30 x 40 ft. laboratory, power house, warehouse, office building, etc. Total estimated cost, $200,000. O. C. Vehling, 511 First Wisconsin National Bank Bldg., Milwaukee, Arch. and Engr.

Ont., Fort William—The Board of Education plans to construct a 3 story technical school building. A steam heating and fan ventilation system will be installed in same. Total estimated cost, $350,000.

Ont., Toronto—Bowles Lunch, Ltd., 149 Yonge St., are having plans prepared for the construction of a 2 story, 50 x 100 ft. lunch building, on Yonge St. A steam heating system will be installed in same. Total estimated cost, $125,000. Harris & Merritt, 53 Yonge St., Arch.

CONTRACTS AWARDED

Mich., Detroit—Young Brothers, 313 Franklin St., have awarded the contract for the construction of a 1 story, 105 x 200 ft. heating plant, on Franklin Ave., to Ernst Brothers, Bagg St. Noted Sept. 2.

Mich., Hamtramck—The Detroit Carrier & Manufacturing Co., Conant Ave., has awarded the contract for the construction of a 2 story, 110 x 133 ft. factory on Conant Ave. and Grand Trunk R. R., to the Charles M. Davis Co., 1323 Woodward Ave. A steam boiler and engine for heating and power will be installed in same.

Mich., Marysville—Pressed Metals of Canada, 12 Adelaids St., Toronto, has awarded the contract for the construction of a 1 and 2 story, 72 x 516 ft. brass foundry, along the St. Clair River, to The Witherspoon-Englar Co., 53 West Jackson Blvd., Chicago, Ill. A steam heating system will be installed in same. Total estimated cost, $95,000.

Mich., Pontiac—The Board of Education has awarded the contract for the construction of a 2 story school building on West Huron St. to W. H. Isgrigg & Sons, Pontiac. Complete steam heating and ventilating plants will be installed in same. Total estimated cost, $270,000.

Mich., Sault Ste. Marie—The city plans to replace the present steam pumping equipment with 4 electrically driven centrifugal units. Estimated cost, $30,000. W. Rich, Engr.

Mo., St. Louis—The Scullin Steel Co., 6700 Manchester Ave., has awarded the contract for the construction of a 1 story, 20 x 60 ft. transformer building at 1815 Knox Ave., to the Fruin Colnon Contracting Co., Merchants Laclede Bldg. Estimated cost, $12,000.

N. J., Atlantic City—Leeds, Lippincott Co. has awarded the contract for the construction of a 14 story, 132 x 145 ft. addition to the Haddon Hall Hotel on North Carolina St. and Boardwalk, to the Roydhouse Arey Co., 112 North Broad St., Philadelphia. A steam heating system will be installed in same. Total estimated cost, $3,000,000.

Ohio, Columbus—George Bobb & Son, 260 East Naghten St., has awarded the contract for the construtcion of a 5 story, 94 x 178 ft. grocery plant and a 40 x 93 ft. cold storage plant, on Front St., to E. H. Lathan & Co., Columbus Savings & Trust Bldg. Total estimated cost, $190,000. The above contract does not include plumbing, heating, electrical work and special equipment which will amount to $65,000.

Ohio, Cleveland—The Martin Bariss Co., 2048 West 3rd St., has awarded the contract for the construction of a 2 story, 36 x 165 ft. saw mill and power house, to W. B. McAllister Co., 2165 East 31st St. Estimated cost, $100,000. Noted Sept. 2.

Ohio, Cleveland — Marcus Loew, 1493 Broadway, New York City, has awarded the contract for the construction of a 1 story, 96 x 130 ft. theatre on East 101st St. and Euclid Ave., to the Craig Curtiss Co., Guardian Bldg. A steam heating system will be installed in same. Total estimtaed cost, $250,000.

Okla., Ada—The city has awarded the contract for constructing and furnishing service and fire pumps, all piping, etc., in connection with the proposed waterworks extensions, to the Merkle Machinery Co., 508 Interstate Bldg., Kansas City, Mo. Total estimated cost, $20,500.

LEGAL NOTICE

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

Of Power, published weekly at New York, N. Y., for Oct. 1, 1919.

State of New York } ss.
County of New York }

Before me, a notary public in and for the State and county aforesaid, personally appeared James H. McGraw, Jr., who, having been duly sworn according to law, deposes and says that he is the Secretary of the McGraw-Hill Co., Inc., publishers of Power, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, McGraw-Hill Co., Inc., 10th Ave. at 36th St., New York, N. Y. Editor, Fred Low, 10th Ave. at 36th St., New York, N. Y. Managing Editor, A. D. Blake, 10th Ave. at 36th St., New York. Business Manager, G. E. Andrews, 10th Ave. at 36th St., New York, N. Y.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent. or more of the total amount of stock.) McGraw-Hill Co., Inc., 10th Ave. at 36th St., New York, N. Y. James H. McGraw, 10th Ave. at 36th St., New York, N. Y. Arthur J. Baldwin, 10th Ave. at 36th St., New York, N. Y. John McGhie, 10th Ave. at 36th St., New York, N. Y. Fred Low, 10th Ave. at 36th St., New York, N. Y. Henry W. Blake, 10th Ave. at 36th St., New York, N. Y. Leonard D. Baldwin, 27 Pine St., New York, N. Y. F. S. Weatherby, 163 Clinton Road, Brookline, Mass. Arthur J. Baldwin, 10th Ave. at 36th St., New York, N. Y. Trustee for Estate of John A. Hill, Morgan Baldwin, Donald Baldwin, Franklin Baldwin, Grace Baldwin and Cynthia Haselton.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is . (This information is required from daily publications only.)

JAMES H. McGRAW, JR.

Sworn to and subscribed before me this 27th day of September, 1919.

[Seal.] MARTIN J. WIEMER.

Notary Public, Kings County Certificate No. 103. Certificate filed in New York County No. 316.

My commission expires March 30, 1920.

PRICES -- MATERIALS -- SUPPLIES

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE—

Fire	50-Ft. Lengths
Underwriters' 2½-in	75c. per ft.
Common, 2½-in	40%

Air	First Grade	Second Grade	Third Grade
½-in. per ft	$0.50	$0.33	$0 22

Steam—Discounts from List

First grade.........30% Second grade.......40% Third grade..... 45%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition.....................65% Best grade.......................35%
Standard.........................50%

Note—Above discounts apply on new list issued July 1.

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	45%	35%
St. Louis	40%	30%
Chicago	20%	10%
Birmingham	35%	30%
Denver	30%	20%

RAWHIDE LACING—20% for cut; 45c. per sq. ft. for ordinary.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.90
Asbestos for high-pressure steam	1.50
Duck and rubber for piston packing	1.00
Flax, regular	1.20
Flax, waterproofed	1 60
Compressed asbestos sheet	90
Wire insertion asbestos sheet	1.10
Rubber sheet	.50
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.20
Asbestos wick, ½- and 1-lb. balls	.85

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin. Ft.	Thickness	Price Per Sq. Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	90
10-in.	1.30	3½-in.	1.05

For low-pressure heating and return lines:
4-ply........................ 58% off
3-ply........................ 60% off
2-ply........................ 62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Pittsburgh	Chicago	St. Louis	Birmingham	Denver
Cup	7	9	6.6	6.7	8½	13
Fiber or sponge	8	10	8.6	13	9	18
Transmission	7	9	8.1	13	8½	15
Axle	4½	6	4.8	4.75	4½	5½
Gear	4½	9	6.1	7.5	8½	8
Car journal	22(gal.)	21(gal.)	4.7	4.7	4½	15¾

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Current	One Year Ago		
White	13.00	11.00 to 13.00	14.00	12 00 to 15.00
Colored mixed	9.00 to 12.00	8.50 to 11.00	11.00	9.50 to 13.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13¼ x 13¼	13¼ x 20½
Cleveland	$52.00	$58.00
Chicago	43.00	45.00

LINSEED OIL—These prices are per gallon:

	New York		Cleveland	Chicago	
	Current	One Year Ago	Current	Current	One Year Ago
Raw in barrels (5 bbl. lots)	$1.75	$1.61	$2.50	$1.98	$1.65
5-gal. cans	1.90	1.76	2.75	2.23	1.85

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	13.00	14.50	14.00	14 50	13 00	14.00
25- and 50-lb. kegs	13.25	14.75	14.25	12.75	13.25	14 25
12½-lb. keg	13.50	15.00	14.50	15.00	13.50	14.50
1-lb. cans	16.00	17.50	.....	.....	16 00	17.00
5-lb. cans	16.00	16.50	.....	.....	15.00	16 00

500 lb. lots less 10% discount; 2000 lb. lots less 10-2½%.

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel 7/16 and smaller	50-10%	55%	55%
Tinned	50-10%	55%	50%

Boiler rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.
New York....$5.25 Cleveland ...$4.00 Chicago......$4.72 Pittsburgh... $4.65

Structural rivets, same sizes:
New York... $5.35 Cleveland....$4.10 Chicago..... $4.92 Pittsburgh....$4.75

REFRACTORIES—Following prices are f. o. b. works, Pittsburgh:

Chrome brick	net ton	$80-90	at Chester, Penn.
Chrome cement	net ton	45-50	at Chester, Penn.
Clay brick, 1st quality fireclay	net M	35-45	at Clearfield, Penn.
Clay brick, 2nd quality	net M	30-35	at Clearfield, Penn.
Magnesite, dead burned	net ton	32.50	at Chester, Penn
Magnesite brick, 9 x 4½ x 2½ in	net ton	80-90	at Chester, Penn.
Silica brick	net M	41-45	at Mt. Union, Penn.

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—Fire Clay, $35 to $50.

Birmingham—Silica, $50 per M; fire clay, $43 per M; magnesite, $80 per ton; chrome, $80 per ton.

Chicago—Second quality, $25 per ton

Denver—Fire clay, $11 per ton.

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	90.00	95.00	70.00	93.00	60.00	96.00
Commercial	55.00	50.00	16.50	23.00	13.00	25.00

SWEEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$21-26	$19.00
Cleveland	20.00	20.00
Chicago	16.50	19.00

In coils an advance of 50c. is usually charged.

COAL—Bituminous:

Prices in effect throughout the United States on Dec. 31, 1918, have been restored by Government order:

NEW YORK
Per net ton, F. O. B.
Tidewater

Central Penna.,
Mine Run or Slack..$5 45
Upper Potomac, Cumberland and Piedmont Fields
Mine Run.......... 6.23
Prepared 5.51
Slack.............. 4.95
Upper ports, 5c. higher..

PITTSBURGH
Per net ton, F. O. B.
Cars at Mine

Slack.....$2.10 @ $2.25
Mine Run. 2.35 @ 2.50
Screened.. 2.60 @ 2.75

PHILADELPHIA
F. O. B. Cars

	Mine	Tidewater
Nut	$5.15	$6.50
Stove	5.05	6.40
Egg	4.80	6.15
Broken	4 90	6.25
Pea	3.75	5.00
Buckwheat	3.40	4.45
Rice	2.90	3.80
Boiler	2.70	3.70
Barley	2 40	3.15

MIDDLE WEST
Chicago quotations, F. O. B. cars at mine

	Springfield Carterville Williamson Franklin Saline Harrisburg	Fulton Peoria	Grundy La Salle Bureau Will
Lump	$2 55 @ $2.70	$2.95 @ $3.10	$3.25 @ $3.40
Washed	2 75 @ 2 90	....	3.45 @ 3.60
Mine Run	2.35 @ 2.50	2.75 @ 2.90	3.00 @ 3.15
Screenings	2.05 @ 2 20	2.35 @ 2.50	2.75 @ 2.90

PIPE—The following discounts are for carload lots f. o. b. Pittsburgh; basing card of Jan. 1, 1919, for steel pipe and for iron pipe:

BUTT WELD

Inches	Steel Black	Galvanized	Inches	Iron Black	Galvanized
⅛, ¼, and ⅜	50½%	24%	¾ to 1½	39½%	23½%
½	54½%	40%			
¾ to 3	57½%	44%			

LAP WELD

2	50½%	38%	2	32½%	18½%
2½ to 6	53½%	41%	2½ to 6	34½%	21½%

BUTT WELD, EXTRA STRONG PLAIN ENDS

⅛, ¼ and ⅜	46½%	29%	¾ to 1½	39½%	24½%
½	51½%	39%			
¾ to 1½	55½%	43%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	48%	37½%	2	33½%	20½%
2½ to 4	51%	40½%	2½ to 4	35½%	23½%
4½ to 6	50%	39½%	4½ to 6	34½%	22%½

Stock discounts in cities named are as follows:

	New York		Cleveland		Chicago	
	Black	Galvanized	Black	Galvanized	Black	Galvanized
¾ to 3 in. steel butt welded	47%	31%	43½%	34½%	57½%	44%
2½ to 3 in. steel lap welded	42%	27%	45½%	30½%	53½%	41%

Malleable fittings. Class B and C, from New York stock sell at list +12½%
Cast iron, standard sizes, 10-5% off.

BOILER TUBES—The following are the prices for carload lots, f. o. b. Pittsburgh:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	40½	3½ to 4½ in.	15½
2½ to 3¼ in.	30½	3 to 3¼ in.	1
2¼ in.	24	2½ to 2¾ in.	+ 1
1¾ to 2 in.	19½	2 to 2¼ in.	16
		1¾ to 1⅞ in.	+29

Standard Commercial Seamless—Cold Drawn or Hot Rolled

	Per Net Ton		Per Net Ton
1 in.	$327	1¾ in.	$207
1¼ in.	267	2 to 2¼ in.	177
1⅜ in.	257	2½ to 3¼ in.	167
1½ in.	207	4 in.	187
		4½ to 5 in.	207

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiations.

ELECTRICAL SUPPLIES

ARMORED CABLE—

B.& S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$104.00	$138.00	$164.00	$210 00
No. 12 solid	135 00	170.00	225.00	265 00
No. 10 solid	185 00	235 00	275.00	325.00
No. 8 stranded	285.00	375.00	520 00	500.00
No. 6 stranded	400.00	500.00	560.00	......

From the above lists discounts are:

Less than coil lots	Net List
Coils to 1,000 ft	10%
1,000 ft. and over	15%

BATTERIES, DRY—Regular No. 6 size, red seal, Columbia or Ever Ready:

	Each, Net
Less than 12	$0.40
12 to 50	.39
50 to 125 (bbl.)	.36
125 (bbl.) or over	.34

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per 100 for couplings and elbows:

	Conduit		Elbows		Couplings	
Size, In.	Black 1,000 Ft. and over	Galvanized 1,000 Ft. and over	Black 100 and Over	Galvanized 100 and Over	Black 100 and Over	Galvanized 1,000 and Over
⅜	$71 15	$76.25	$17.04	$18.18	$5.38	$5.74
½	71.15	76.25	17.04	18 18	6.25	6 70
¾	93.96	100 86	22.23	23.93	8.97	9.57
1	138.39	149 09	33.19	35.41	11.66	12.44
1¼	187.91	201.71	42.62	45.31	16.10	17.12
1½	224.68	241.18	56.82	60.62	19.89	21.15
2	302.29	324.49	104 17	110.77	26.52	28.20
2½	477.95	513 05	170.46	181.26	37.88	40.28
3	625.00	670.91	454.56	483 36	56.82	60 42
3½	779.24	834.44	1,003 82	1,067.42	75.76	80 56
4	945.03	1,010.43	1,160 08	1,223.57	94.70	100.70

5% cash 10 days.

From New York Warehouse—5% cash.

Standard lengths rigid, 10 ft. Standard lengths flexible, 100 ft. Standard lenghts flexible, ¾ to 2 in., 50 ft.

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.	
7/32	250	$0.05½	Coils.......55% off Less coils...45% off
¼	250	.06	
⅜	250	.09	
½	200	.12	
⅝	200	.15	
¾	150	.18	
1	100	.25	
1¼	100	.33	
1½	Odd lengths	.40	
2	Odd lengths	.55	

CUT-OUTS—Following are the net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. P.	$0.24
D. P. M. L.	.11	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S. B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0–30 Amp.	31–60 Amp.	60–100 Amp.
D. P. M. L.	$0.33	$0 84	$1.68
T. P. M. L.	48	1.20	2.40
D. P. S. B.	.42	1.05	....
T. P. S. B.	.81	1.80	....
D. P. D. B.	.78	2.10	....
T. P. D. B.	1.36	3.60	....
T. P. to D. P. D. B.	.90	2.52	....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$16 75
No. 16 cotton twisted	22 00
No. 18 cotton parallel	19 80
No. 16 cotton parallel	25.75
No. 18 cotton reinforced heavy	30 00
No. 16 cotton reinforced heavy	36.50
No. 18 cotton reinforced light	23.40
No. 16 cotton reinforced light	27.50
No. 18 cotton Canvasite cord	26.00
No. 16 cotton Canvasite cord	28.50

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.25
35-amp. to 60-amp.	100	.36
65-amp to 100-amp.	60	.90
110-amp to 200-amp.	25	2.00
225-amp to 400-amp.	25	3.60
425-amp to 600-amp.	10	5.60

600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.40
35-amp. to 60-amp	100	.60
65-amp. to 100-amp	60	1 60
110-amp. to 200-amp	25	2.60
225-amp. to 400-amp	25	5.50
450-amp. to 600-amp	10	8.00

Discount:	
Less than 1-5th standard package	30%
1-5th to standard package	40%
Standard package	62%

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package	$4.75 C
0–30 ampere, less than standard package	6.00 C

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B— Watts	Plain	Frosted	No. in Package	Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.35	$0.38	100	75	$0.70	$0.75	50
15	.35	.38	100	100	1.10	1.15	24
25	.35	.38	100	150	1.65	1.70	24
40	.35	.38	100	200	2 20	2.27	24
50	.35	.38	100	300	3.35	3.35	24
60	.40	.45	100	400	4 30	4 45	12
100	.85	.92	24	500	4.70	4 85	12
				750	6.50	6.75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

		Each
Hubbell, porcelain No. 5406,	standard package 250	$0.24
Hubbell composition No. 5467,	standard package 50	.32
Benjamin swivel No. 903,	standard package 250	.20
Hubbell current taps No. 5638,	standard package 50	.40

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York

No.	Soild Single Braid	Solid Double Braid	Stranded Double Braid	Duplex
14	$12 00	$14.00	$13.90	$25 00
12	13 25	15 70	18.05	30.70
10	18.30	21.00	23.85	41.60
8	25 54	28.60	32.70	56.77
6	......	......	51.40	......
4	......	......	70 00	......
2	......	......	101.80	......
1	......	......	131.86	......
0	......	......	160 00	......
00	......	......	193.50	......
000	......	......	236.20	......
0000	......	......	288.60	......

SOCKETS, BRASS SHELL—

¼ In. or Pendant Cap			⅜ In. Cap		
Key, Each	Keyless, Each	Pull, Each	Key, Each	Keyless, Each	Pull, Each
$0 33	$0.30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package	+20%
1-5th to standard package	+10%
Standard package	—15%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B.& S. regular spools (approx. 8 lb.)	36c. lb.
No. 18 B.& S. regular 1-lb. coils	37c. lb.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb., 50c. lb., 100 lb. lots	55c. lb.
Rubber tape, ¾ in., less 100 lb., 65c. lb., 100 lb. lots	60c. lb.
Wire solder, less 100 lb., 50c. lb., 100 lb. lots	46c. lb.
Soldering paste, 2 oz. cans Nokorode	$1.20 doz.

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole Each	Fore Pole Each
30	$0.42	$0 68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.60	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole Each	Fore Pole Each
30	.70	1.06	1.60	2.12
60	1.16	1 80	2.70	3.60
100	2.38	3.66	5.50	7.30
200	4.40	6.76	10.14	13.50

Discounts:

Less than $10.00 list value	+ 5%
$10 to $25 list value	— 8%
$25 to $50 list value	—14%
$50 to $200 list value	—20%
$200 list value or over	—25%

POWER

Volume 50 New York, November 11-18, 1919 *Number 19*

Published December 16, with current news

"A chip off the old block"
Breul

THE RUMFORD FALLS HYDROELECTRIC PLANT

The hydro-electric station atop one of the many hills of Rumford is the largest of Maine's water-power developments; its ultimate capacity is 40,000 kw. It is the fourth plant erected on the same site since 1892. Nearly all present output is consumed within 6000 ft. of the station. There are no ice troubles here. Immense storage is afforded by the famous Rangeley Lakes.

IN 1892 the City of Rumford, Me., was a wooded island in the Androscoggin River. Today it boasts 10,000 population, is growing apace and has one of the finest residential parks in New England. The whole is the outcome of two factors—the near-by fall of the Androscoggin and the enterprise of the late Hugh J. Chisholm, Sr. The story of Chisholm and Rumford is one of absorbing interest, which, unfortunately, lack of space here forbids; but the engineering details of the power plant, which made Rumford possible, are no less absorbing. These are the subject of the present article.

The Androscoggin is one of the six large rivers of Maine, and rises in Parmachenee Lake, and the Rangeley Lakes system, which are nearly on the border of the most northeastern part of New Hampshire, where that state and Maine join. The river flows south-southwest, entering New Hampshire a few miles above Umbagog Lake, turning southwest at a point directly east of Crystal, N. H., and describing an arc between this point and Berlin Falls. It turns at right angles here, flowing east, again entering Maine just east of Shelburne, N. H., and directly west of West Bethel, Me. From Bethel to Mexico, a suburb of Rumford, it flows northeast, then southeast to Walkers, northeast to Riley, directly south to Auburn, then southeast to Brunswick, where it empties into the Atlantic.

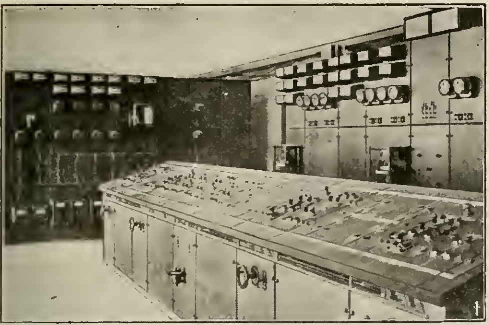
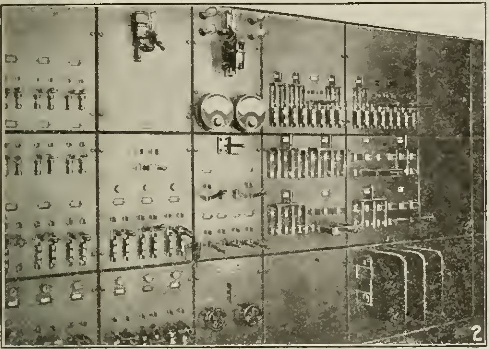
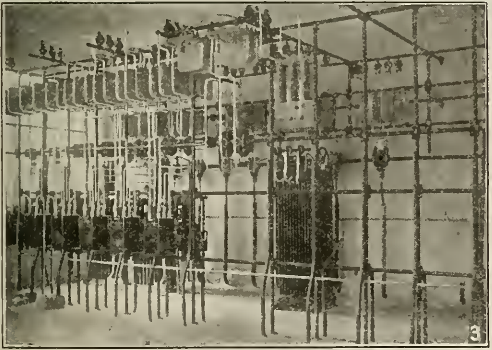
The Androscoggin River basin above the plant at Rumford Falls has an area of 9388 square miles. Excellent storage is afforded by the Rangeley Lakes, of which there are five—seven if Pharmachenee and Umbagog are included, as they should be, for all empty into the river. The present storage capacity above Errol Dam, which is at the outlet of Umbagog Lake, the lowest of the system, is about 29.5 billion cubic feet, 9.6 billion cubic feet of which is from the Aziscohos Reservoir; 8 billion cubic feet additional may be had at an estimated total cost of $200,000. By means of the dams at the lakes the natural level in one was raised 4 ft. and in another 12 ft., 20 ft. in another, and 45 ft. in another. Rangeley, the uppermost of the system, is at an elevation of 1500 ft. above the sea. When more fully utilized, the Androscoggin will yield over 160,000 hp., of which 120,000 is developed. All present developments represent a total cost of $14,000,000.

Rumford Falls is a series of three rapids extending over about one mile and having a total drop of 180 ft. The first drop is 100 ft., used by the plant that is the subject of this article; the second drop, 50 ft., used on wheels in the mills of the International Paper Co.; the third, 30 ft., developed mechanically by the Oxford Paper Co. Water does not back up in the tailrace as at many plants during high water or high station load, because it is taken from one canal and discharged into another canal.

New Power House of Large Capacity

The new power house, Figs. 1 to 8, now built and capable of extension, will have an ultimate capacity of 40,000 kw. in five vertical units of 8000 kw. each. A new concrete dam 480 ft. long and 50 ft. high has been built. The dam and power house are shown in the headpiece. Water comes to the gatehouse through a concrete and ledge canal 100 ft. wide and 15 ft. deep. The spillway capacity is capable of passing the maximum flood of 55,000 sec. ft. Four sluice gates, power and hand operated, are reached from a girder and slab bridge. The racks at the gatehouse are two in number, the outer having bars 5 in. apart to throw off the large floating substances, the inner with bars 2½ in. apart. Trash-discharge flumes are provided. The interior of the gatehouse is shown in Fig. 5.

It was a difficult job to build the new station without interrupting operation of the old plant. To accomplish this it was advisable to bore tunnels from the headworks or gatehouse to the turbines, as new canals to carry water to the machines would have to cross the penstocks of the old machines. The tunnels are in solid granite, but they are short. Two are completed and lined with reinforced concrete, a third is bored through but not lined, and two more have been started, borings having been made at both ends of each. The headwork is finished, so that the old power house may be taken out and the new one extended; the switchboard and conduits for all the future machines are already installed. The foundations are of concrete, the walls of red brick, the floors of white tile, the turbine-room interior of buff brick, the ceilings and wall panels white. See Fig. 8.

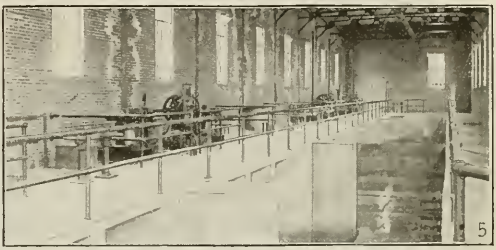
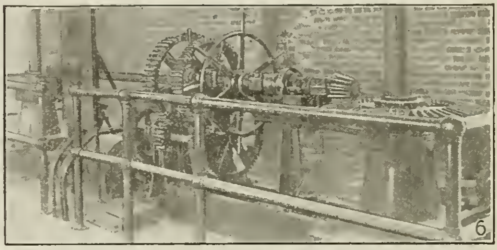
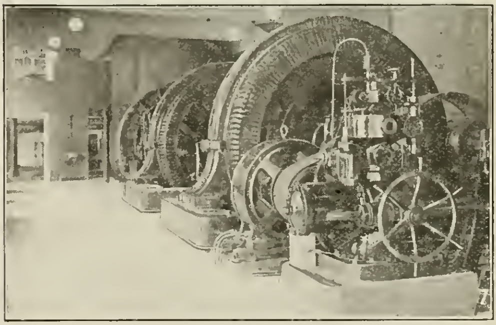




FIG. 1 TO 7. SOME VIEWS OF THE RUMFORD FALLS HYDROELECTRIC PLANT

Fig. 1—The benchboard and switchboard. Fig. 2—Station-service switchboard. Fig. 3—Some of the high-tension electrical work. Fig. 4—Looking down the intake canal toward the gatehouse. Fig. 5—Gatehouse interior. Fig. 6—Gate-operating mechanism. Fig. 7—The two units in the old station.

The old station has two 6000-hp. 400 kv.a. 2300-volt machines, Fig. 7. Each operates at 400 r.p.m. These machines are, of course, controlled from the new benchboard. Their runners are of bronze.

The new units, two of which are now in operation, are each of 10,000-hp., 8000 kv.a., 11,000-volt, 40-cycle 96 ft. head, 200 r.p.m. The turbines are of the Wellman-Seavers-Morgan type, with Lombard governors and Westinghouse generators. The runners are of cast steel, and a reserve runner is kept handy for possible breakdown. The runners and all iron parts of the machines exposed to water are painted with red lead to protect against rust. It is interesting to see how well preserved and little worn this red lead is on one of the wheels, which, when the writer saw it, had been in service many months; the metal beneath is, of course, as bright and free from corrosion as when first machined.

The governor fluid is oil, no so-called soluble oil being used; the oil pressure is 200 lb. In accordance with modern practice the governor-pressure piping is sectionalized so that in case of breaks or serious leaks the affected section may be isolated until repairs are made, thus in no way interfering with service of the station. The system contains 5000 gal. of oil. For the two old turbines the governor pressure is individual.

The station has two independent exciters, one water-driven of 100-kw. capacity, and one motor-driven of 75-kw. capacity. Each generator has a 90-kw. exciter directly connected to it. A 150-amp.hr. storage battery is provided for emergencies. This battery automatically cuts in if the exciters happen to go dead.

At Rumford ice troubles are practically unknown. There are no provisions at the station for fighting ice of any kind; they are not needed. For eight miles back of the dam at the plant the backwater extends, covering the shallow places where frazil ice previously formed. The Androscoggin is in a cold region, and the river freezes completely over and remains frozen until the warmth of spring breaks up the ice. An open surface of river does not exist in winter, and therefore one of the essential conditions for the formation of frazil ice is never present. Surface ice, when broken and floating, is carried away from the forebay by the main stream.

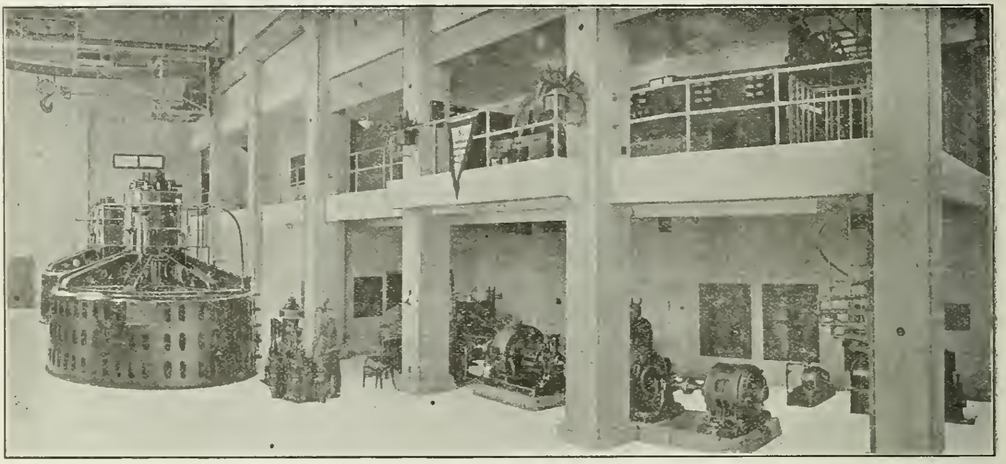


FIG. 8. VIEW INSIDE THE TURBINE ROOM, RUMFORD FALLS POWER COMPANY

The two old turbines furnish current at 2300 volts, this being stepped up to line voltage of 11,000 by Allis-Chalmers transformers. The transmission lines are fitted to carry current at 22,000 volts when the transmission distances become greater. The demand at Rumford Falls is for 24-hour power, and 90 per cent of the plant's capacity is consumed within 6000 ft. of the power station. The switchboards were built by the General Electric Co.

Hugh J. Chisholm is president of the Rumford Falls Power Co., and Charles A. Mixer is resident chief engineer in charge of hydraulic and real estate departments. C. T. Maynard is engineer in charge of the electrical department.

Cheap power and the large scale on which the Rumford Falls Power Co. has developed it will unquestionably greatly stimulate the industrial growth of Rumford. The place is already famous for its paper, and as many kinds of wood, veritable forests of it, surround the town, wood-working plants of various kinds are sure to be attracted.

Legal Aspects of Smoke Nuisances

By Arthur L. H. Street

The latest authoritative judicial determination concerning smoke as an abatable nuisance seems to have been made in the recent decision of the Georgia Supreme Court, handed down in the case of Holman vs. Athens Empire Laundry Co., 100 Southeastern Reporter, 207.

In this suit the trial judge ruled that the plaintiff, the owner of a nine-story office building in Athens, failed to make out a case for an injunction against the defendant laundry company's continued use of soft coal in operating its steam-power plant across the street in a two-story building. But, on an appeal taken by the plaintiff, the Supreme Court reversed the decision, holding that the trial judge committed an error in refusing to permit the jury to determine whether the defendant's use of soft coal under the particular circumstances constituted a nuisance.

The defendant had operated its plant for several years before the plaintiff constructed his office building, but appears to have used coke as fuel most of the time. The laundry smoke-stack is about sixty feet high, the top being on a level with the sixth story of the plaintiff's building.

The plaintiff admitted that the defendant's use of coke caused no substantial injury to his building or discomfort to his tenants, but complained that when soft coal was adopted by the defendant as a fuel, dense black smoke was blown against and into the building when the wind happened to be in that direction. Loss to the plaintiff through discoloration of the interior of the building and threatened loss of tenants were claimed.

The defense contended that coke could no longer be obtained in the local market excepting at prohibitive prices, that no more smoke was emitted than was absolutely necessary in the proper operation of the boiler, that the power plant was operated by a skilled fireman and engineer, that the plaintiff himself used soft coal in the operation of the heating and power plant in his building and caused injury and annoyance to the defendant when eddies of smoke were forced down by air currents and atmospheric conditions.

At the trial the plaintiff offered evidence tending to show that coke could be obtained at reasonable prices and that the volume of smoke thrown from the defendant's plant could be gradually reduced and controlled by the use of modern appliances.

The following statements of law are to be gleaned from the opinion on appeal:

> Where a nuisance affects the public generally, proceedings for its abatement should be brought in the name of the state, and not by one member of the public so affected. But where a nuisance, although public in nature, causes special damage to a private citizen, he may maintain an injunction suit in his own name. And it is found that plaintiff's evidence justified the bringing of suit by him.
>
> Theoretically, every person has the natural right to have the air diffused over his premises in its natural state, free from all artificial impurities. . . . If this rule were literally applied, its application would seriously disturb business, commerce and society itself. Hence, by air in its natural state and free from artificial impurities is meant pure air consistent with the locality and the nature of the community. . . . The use of fuel in the home, the place of business and the manufacturing establishment is necessary. In proportion as the population thickens, the impurities thrown into the air are increased. The pollution of the air, actually necessary to the reasonable enjoyment of life and indispensable to the progress of society, is not actionable; but the right (and such it must be conceded) must not be exercised in an unreasonable manner so as to inflict injury upon another unnecessarily. . . .
>
> Smoke is not in itself a nuisance. . . . To constitute smoke a nuisance, according to the authorities, it must be such as to produce a visible, tangible and appreciable injury to property or such as to render it specially uncomfortable or inconvenient or materially interfere with the ordinary comfort of human existence. . . .
>
> That the business itself is offensive to others or that property in the neighborhood of such business is necessarily adversely affected thereby, or that persons of fastidious taste would prefer its removal is not sufficient. Applying the foregoing principles to the case in hand, the defendant may make use of its property and carry on any business, not in itself a nuisance, that produces no unnecessary, unreasonable, unusual or extraordinary impregnation of the air with smoke or soot, to the sensible inconvenience and discomfort of the plaintiff's tenants or to the actual, tangible and substantial injury of the plaintif's realty. Whether a nuisance in fact existed, in the circumstances of this case, was at least a question for the jury.

In the course of the discussion the Supreme Court refers to a decision of the Tennessee Supreme Court, handed down in the case of Union Planters' Bank and Trust Co. vs. Memphis Hotel Co., 139 Southwestern Reporter, 715. In that case, which arose in Memphis, the Tennessee court refused to grant an injunction which in effect would have required a fifty-foot extension of a smoke-stack to avoid smoke blowing into the windows of a fifteen-story building. The court took the view that it would be inequitable to require the owners of established steam-power plants in the hearts of populous cities to keep on extending the stacks to meet the convenience of occupants of buildings near-by of increasing height, noting that if that principle were adopted the defendant might in time be required to adjust its smoke-stack so as to discharge the smoke at a level above the top of a thirty-story or even higher building.

But the Georgia court distinguishes this decision as a precedent for a holding in the case in hand, on the ground that in the Tennessee case it was not claimed that the defendant could avoid annoyance to occupants of the plaintiff's building by any substitution of fuel.

The two courts seem to take divergent views on one point—the effect of a complaining person's use of the same kind of fuel that he objects to being used by a neighbor. The Tennessee court suggested that had plaintiff in the Memphis case objected to defendant's use of soft coal, the objection would not have been considered because plaintiff itself used that kind of coal. On the other hand, the Georgia court holds that a plaintiff is not necessarily precluded, intimating that the defendant's remedy is to seek such an injunction against the plaintiff as the latter seeks against him. A decision of the Michigan Supreme Court is cited as supporting this latter view.

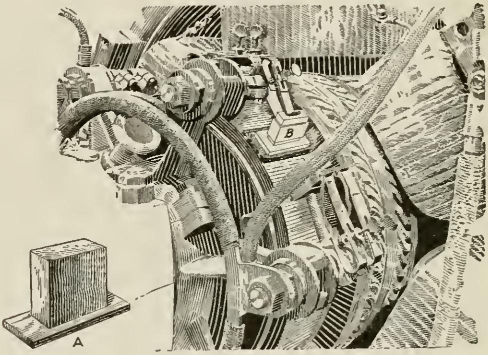
Concluding its opinion, the Georgia Supreme Court says:

> Equity is asked to do no more than to restrain the defendant from using soft coal, that is, "such coal as throws out a black, dense smoke," and the evidence in the record is such as to authorize a finding by the jury that the use of coke was at once convenient and practical. The court is not asked to abate the defendant's laundry. If a case be otherwise made out, injunctive relief cannot be denied the plaintiff, although the nuisance results from smoke alone.

Preventing Sparking at Commutators on Slow Speed Machines

By B. A. Briggs

On slow-speed direct-current machines the peripheral velocity of the commutator is not high enough to throw off, by centrifugal force, the small particles of dust and dirt that may collect on the commutator surface; consequently, there is always more or less sparking due to the particles of dirt causing minute arcs across the mica insulation. Although these arcs may not cause serious trouble, they are not the most pleasant things for the maintenance man to look at, especially when the moderate- and high-speed machines are operating sparkless. Cleaning the commutator on a slow-speed machine is not very effective in relieving the sparking; although it gives temporary relief, the trouble soon appears again The scheme illustrated in the figure is one that has proved to be very satisfactory in preventing the arcs in question. An additional brush-holder *B* is placed on one of the studs and turns in the opposite direction from the other brush-holder. In this brush-holder is placed a fiber or wooden brush, under the end of which is placed a piece of canvas three or four folds thick. The brush is made with an end considerably larger than the holder, as shown at *A*. This brings the canvas in contact with a greater area of the commutator. The canvas wipes the dirt off the commutator and prevents the pin arcs. If the commutator is of a width to warrant it, two or more of the wiping brushes may be used. The canvas will have to be turned or changed from time to time, the frequency depending upon how constantly the motor is used and upon the amount of dirt suspended in the surrounding atmosphere.



CLEANING BRUSH IN POSITION ON COMMUTATOR

The Absorption Refrigerating Machine—I

By H. J. MACINTIRE
Professor of Mechanical Engineering, University of Idaho

THERE is a saying among salesmen for refrigerating machines that it is easier to teach a man without any idea of engineering about the care and operation of the absorption refrigerating machine than it is to get a licensed engineer to learn these things. This statement is far-fetched, and yet there is something in the remark. Perhaps it is that the absorption machine is a mass of valves and fittings; perhaps it is that there are no moving parts except a small pump hidden off there in the corner, or perhaps the engineer is hunting for something hard and overlooks the fact of the simplicity of this form of refrigerating machine. Be this as it may, the writer has figured the matter out for himself, and the following is his own explanation, offered to the reader in the hope that it may be of some assistance in understanding and operating this important machine.

The Compression Refrigerating Machine

Before going into the subject proper, it will be well to consider the compression refrigerating machine. The ammonia compression machine is only a pump. It takes a vapor or slightly superheated gas at a nominal pressure and increases the pressure some six or twelve times, enough so that when the compressed gas is cooled by water from a well or river or pond, it will be condensed. Now, in steam-economy practice we always speak of the water rate of a steam engine, meaning the number of pounds of steam per hour used to obtain one horsepower for the same hour. Likewise, in refrigeration the amount of refrigeration is dependent on or proportional to the weight (or number of pounds) of ammonia compressed and evaporated per hour. A 9 x 9-in. single-acting compressor (two-cylinder) operated at 140 r.p.m. will perform a duty at the rate of 20 tons of refrigeration per 24 hours under standard conditions (zero degrees boiling temperature of ammonia), but it will be 25 tons with a higher back pressure (suction pressure) and 15 tons at a lower back pressure. The reason for this is that the refrigerating duty is proportional to the weight of ammonia taken into the cylinder and is not dependent on the piston displacement (which was the same in each of the three cases mentioned). In other words, the volume occupied by a pound of dry, saturated ammonia is always the same for a particular pressure but is different for different pressures, being greater at low pressures. In consequence, the greatest weight is taken into the compressor cylinder when the suction pressure is highest, and therefore the tonnage must also be greatest. The compressor, then, is only a pump, which simply compresses the gas to a point where it can be condensed into liquid ammonia. Now, how about the absorption apparatus?

The absorption machine is different and yet it obtains the same results. It has to increase the pressure to the same amount if the ammonia from the expansion coils is to be condensed. And yet it is different because it has no pump to compress the gas. In fact, the absorption machine uses only heat to cause the increase in pressure—heat from boiler steam or exhaust steam or heat from any other source. The compressor is replaced by a distilling apparatus, more like the stills used in fractional distillation of alcohol or lighter grades of oil. This ammonia still contains a solution of ammonia and water. It must be understood that water can dissolve a certain amount of ammonia, depending on its temperature and the pressure exerted on it, and that it may be concentrated with a certain percentage of ammonia when the pressure and temperature are of a certain amount. Increasing the pressure or decreasing the temperature will enable the water to absorb more ammonia. Likewise, if a solution has its temperature raised and the pressure is kept the same, there will be a point where some ammonia will be driven off as a gas.

Action of the Generator

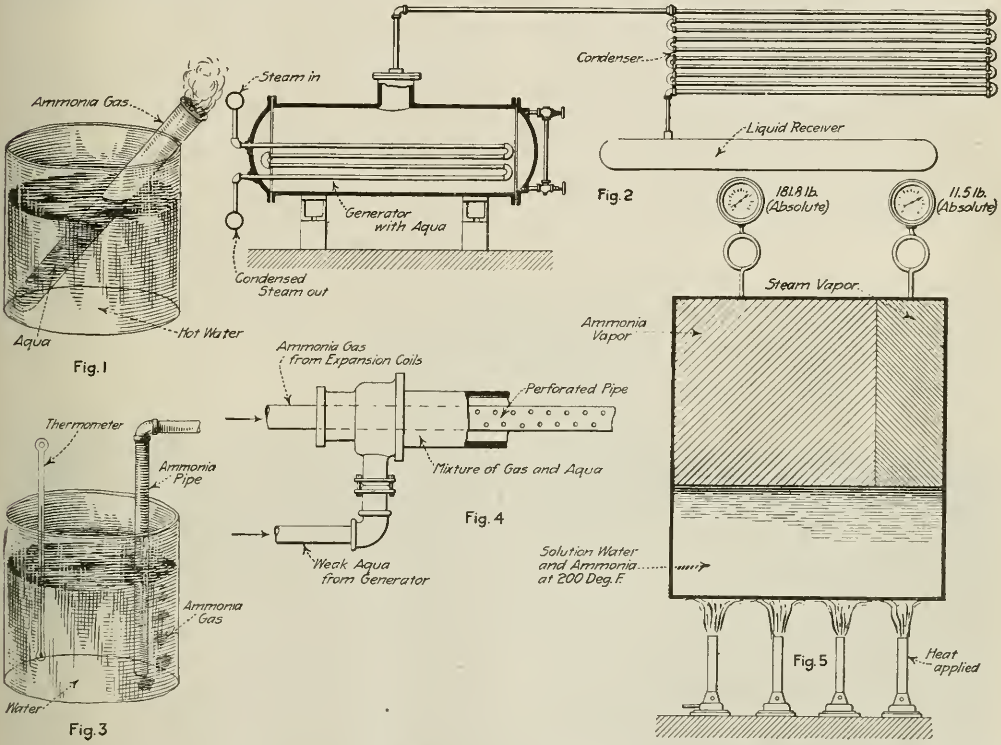
The action of the still, or the so-called generator, is shown in Fig. 1, which represents a solution of ammonia and water (called aqua ammonia) contained in a glass tube, and all immersed in a glass of hot water. The heat taken up by the aqua drives off some ammonia gas as shown, and the aqua which remains is one of less concentration. In Fig. 2 the absorption machine is more nearly represented. The large vessel contains the aqua, which is under a pressure determined by the action of the condensers. The coils within this vessel are the steam-heating coils which keep the aqua hot and provide the necessary heat for driving off the gas into the condenser, in the same manner as in Fig. 1. As the action continues, the concentration of the aqua would become less and less and finally the ammonia gas would be entirely removed unless means could be found to keep the concentration up to full strength. But first let us see what takes place after boiling the liquid ammonia in the expansion coils.

System May Operate Direct Expansion or With Use of Brine

The gas enters the condenser as a slightly superheated vapor under pressure (similar to the action of the compression cycle) and is condensed. The condenser, receiver and expansion coils are substantially identical with those for the compression machine because the liquid ammonia is likewise identical. But there is no compressor to take the low-pressure gas from the expansion coils. The absorption refrigerating system may operate direct expansion or with the use of brine. In the latter case the expansion piping is arranged for in a so-called brine cooler. The condenser cannot condense it again into liquid ammonia unless its pressure is increased some six to twelve times. It is necessary to get this gas into the generator again. It could be pumped in as *gas*, but if that were done, we might just throw away the generator shown in Fig. 2 and use a compressor. Therefore, it is clear that some convenient and economical means must be obtained for getting the ammonia gas into the generator. This is done by dissolving the gas in water and forming a so-called strong aqua.

Water has a great ability for absorbing ammonia. It will dissolve several hundred times its volume of the gas. For instance, a pound of NH_3 (ammonia) at standard pressure, 15.25 lb. gage, will occupy 9.2 cu.ft. If weak aqua of 20 per cent. concentration is brought over from the generator (that is the only water available in the absorption system) and this pound of gas is allowed to dissolve in it, say at 10 lb. gage and 90 deg. F., there would be required about 6.9 lb. of the resulting mixture to be pumped into the generator. This would occupy, roughly, 0.115 cu.ft., or about one-eightieth as much as if the gas as a gas had been compressed in a compressor under standard suction pressure. And it is evident that the size of the pump (the piston displacement required) is not affected by change of boiling temperature of the ammonia in the cooling coils. The usefulness of the absorption machine for low-temperature work is therefore self-evident.

The foregoing action can be shown by Fig. 3 where gas is allowed to bubble into a part of water. The gas is quickly dissolved so that the bubbles do not reach the top. In the absorption machine the system is a closed one, and therefore it appears more like Fig. 4, which shows the usual type of atmospheric absorber. Here the inner pipe extends part way the length of the stand and is perforated as shown. Weak aqua enters on the bottom left side and mixes with the gas, and the current carries the mixture and dissolved gas into the upper pipes. But whereas in Figs. 1 and 2, it required heat to cause the gas bubbles to occur, yet the reverse action takes place in Figs. 3 and 4 and heat is generated when the dissolving action which forms strong aqua takes place, and the thermometer shown in Fig. 3 will indicate the rise in temperature as heat is evolved during solution. However, a rise of temperature could not be allowed in Fig. 4 or a temperature soon would be obtained which would prevent further dissolving of gas. So this heat of solution is removed as promptly as it occurs by means of cooling water, shown at the right in Fig. 4.



FIGS. 1 TO 5. ILLUSTRATING, IN ELEMENTARY WAY, THE ABSORPTION REFRIGERATION SYSTEM

The strong aqua pump then takes the strong aqua from the absorber at a pressure slightly higher than the boiling pressure of the ammonia in the expansion coils, and pumps it into the top of the generator, where it mixes with the aqua there. As weak aqua is heavier than strong, the solution at the bottom should be the weakest. It is customary to connect the bottom of the generator with the line going to the absorber, in order that the necessary liquid be obtained to dissolve the gas. The elementary absorption system, then, consists of a generator where the ammonia gas is driven off under condenser pressure, a condenser where the gas is condensed, a set of expansion coils where the gas is vaporized, an absorber where the gas enters a solution again, and finally an aqua pump to drive the strong aqua into the generator. The machine could work under these conditions, but not very economically.

One additional piece of apparatus required is the so-called exchanger, an apparatus required for reasons of economy. The strong aqua is cold—as cold as the water used in the absorber will allow it to be. To put cold strong aqua directly into the generator would be as unwise as to pump cold feed water into a boiler.

Likewise, the weak aqua leaves the generator at a temperature somewhat less than the temperature of the steam used in the steam coils. It would be impossible to get satisfactory action in the absorber until the temperature of this aqua is reduced, say, to 100 deg. F. or less. Therefore, by the use of an exchanger, designed for counterflow, the strong aqua takes heat from the weak aqua, and the former is made hot while the weak aqua is cooled.

Finally, though the absorption machine would work economically with the apparatus already mentioned, it would not be practical because there would be too much steam condensed with the ammonia in the condenser, and therefore something extra is still needed. Let us consider Fig. 5, which shows what really takes place.

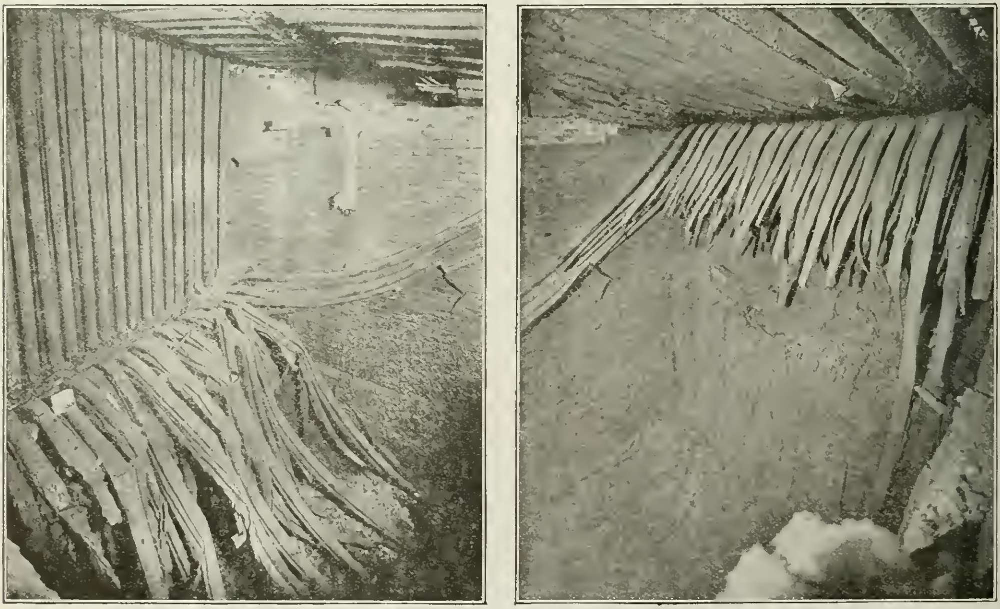
As the aqua is heated by the steam coils, its temperature finally becomes constant at, say, 200 deg. F. Assume that the condensing water cools the liquid ammonia to 80 deg. F. Then the pressure of the vapor mixture in the generator (and in the condenser) will be approximately that resulting from the sum of the partial pressures due to the vapor tension of the water vapor acting alone and the ammonia pressure acting alone. The pressure of the ammonia will be nearly that corresponding to a condensing temperature of 90 deg. F. or 181.8 lb. absolute added to the amount due to a water temperature of 200 deg., which will give an approximate steam pressure of 11.5 lb. absolute. The total pressure is about 193.3 lb. absolute, or 178.6 lb. gage.

So not only is there an increase of pressure on account of the distilling action, but steam itself will be generated (some 5 per cent.) which mixes with the superheated ammonia and passes out of the generator. If no provision was made to the contrary, the ammonia condensed in the condenser would also condense steam. As time intervened, water would accumulate and the result would be a deadening of the action of the cooling coils, requiring a lower boiling pressure to get the same boiling temperature; in fact, proper action would soon cease. So provision must be made to remove as much of the steam as is possible before letting the ammonia gas pass into the condenser.

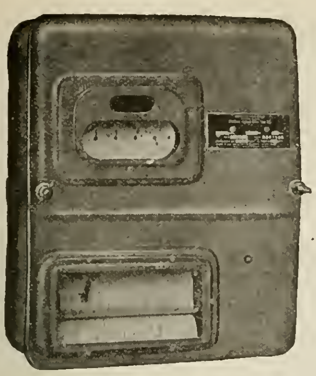
The result is that a water-cooled rectifier or dehydrator is used to reduce the temperature of the gases passing out of the generator. This device is simply a preliminary condenser, but is operated to reduce the temperature only to within 10 to 20 deg. of the temperature of condensation of the ammonia—in this case to 100 deg. F. to 110 deg. F. The steam will be condensed almost completely, and the condensate will absorb some ammonia gas, thereby forming a strong aqua. This liquid will be caught in a separator trap and will flow by gravity back to the generator. The remaining vapor, under reduced temperature, flows into the condenser, as in the compressor machine.

To resume, the steam-heated coils cause superheated ammonia gas and steam to pass out of the generator into a water-cooled rectifier. Here the steam is condensed and is trapped off back to the generator. The anhydrous gas is condensed in the condenser, and boils into a gas again under the proper reduced pressure in the expansion coils. This gas is absorbed by precooled weak aqua from the generator at about the expansion-pipe pressure, and the resulting cold strong aqua is pumped into the generator again. Between the pump and the generator is placed the counter-current exchanger. Of the apparatus mentioned, the aqua pump is the only one which moves.

(*The second part of this article, soon to appear, will consider the operation of the absorption machine.*)



MELTED TUBES OF A WATER-TUBE BOILER THAT WAS ALLOWED TO BECOME EMPTY OF WATER



Explanation and Measurement of Maximum Demand

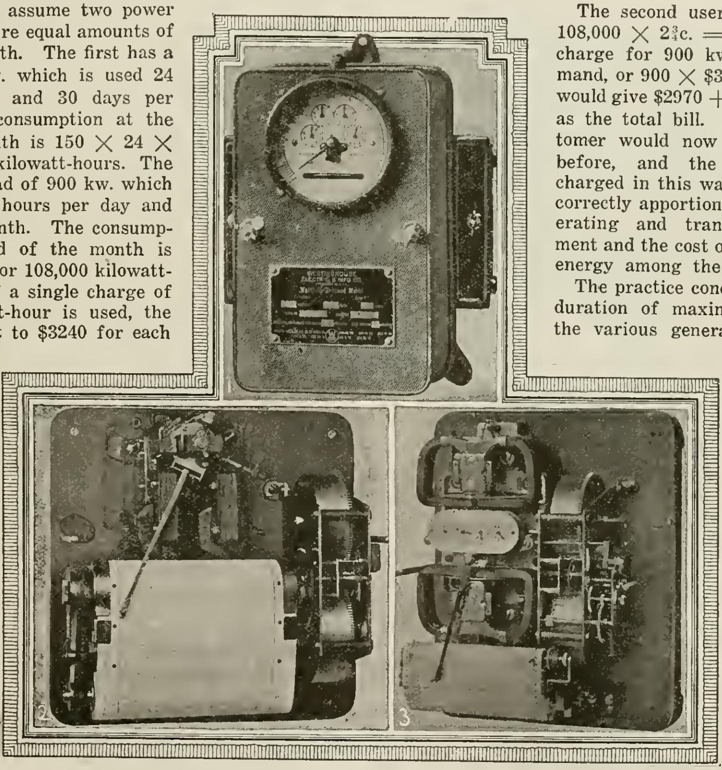
By

Victor H. Todd

An Explanation Is Given of What Maximum Demand Is and How It Affects the Charges for Electrical Energy. Attention Is Called to Different Types of Demand Indicators, and One Type Is Described.

THE cost of supplying electric energy may be divided into two distinct parts—the initial cost of equipment for generating, transforming and transmitting the energy, and the cost of actually performing this work. It is therefore apparent that the user of the energy should pay for the service according to two rates—one based on the cost of equipment necessary to supply the greatest amount of energy required at any time, called the "maximum demand," and one based on the cost of each kilowatt-hour consumed.

In order to demonstrate that a single charge, based on the kilowatt-hour consumption alone may not be the most fair rate, assume two power users who require equal amounts of energy per month. The first has a load of 150 kw. which is used 24 hours per day and 30 days per month. The consumption at the end of the month is 150 × 24 × 30, or 108,000 kilowatt-hours. The second has a load of 900 kw. which is used only 6 hours per day and 20 days per month. The consumption at the end of the month is 900 × 6 × 20, or 108,000 kilowatt-hours. Now, if a single charge of 3c. per kilowatt-hour is used, the bill will amount to $3240 for each user. However, in the second case, to supply 900 kw. instead of only 150 kw., the generating company had to have larger generators, transformers and lines, with their much greater cost, and be ready to serve the user at any minute of the 24 hours, although the user's motors were idle for 18 hours per day. Apparently, this is not fair; the user should pay for this "readiness-to-serve."



FIGS. 1 TO 3. INSTRUMENTS FOR MEASURING MAXIMUM DEMAND

Now, suppose the charge, instead of being 3c. per kilowatt-hour, was changed to 2$\frac{3}{4}$c. per kilowatt-hour., with an additional charge of $3 per month for each kilowatt of the largest load taken; that is, the "Maximum Demand." In the previous examples, the first user's bill would be 108,000 × 2$\frac{3}{4}$c. or $2970, plus the charge for 150 kw. maximum demand, or 150 × $3 = $450, which would give $2970 + $450 = $3420, the same as before.

The second user's bill would be 108,000 × 2$\frac{3}{4}$c. = $2970, plus the charge for 900 kw. maximum demand, or 900 × $3 × $2700, which would give $2970 + $2700 = $5670, as the total bill. The second customer would now pay more than before, and the extra amount charged in this way is supposed to correctly apportion the cost of generating and transmitting equipment and the cost of generating the energy among the various users.

The practice concerning the time duration of maximum demand of the various generating companies varies over a wide range. One minute is about the minimum time for taking a maximum demand for the purposes of rate making; one hour is about the maximum time and a generally used interval. Half-hour periods are frequently used, but a shorter period than one-half hour is hardly justifiable, as there is no part of the normal generating equipment that should reach its limiting temperature in less than half an hour.

The short-time intervals are used generally to catch and discourage short-time peaks which may be eliminated by proper manipulation of load. For instance, a number of electric cranes or derricks or elevators may draw a fairly steady load if operated in rotation, or at different time intervals, but if they all start at the same time, they may draw an excessive short-time load.

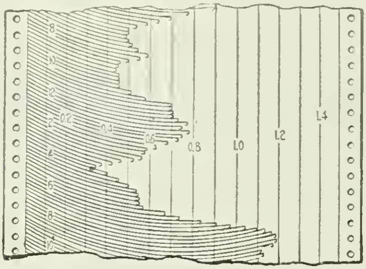


FIG. 4. FIFTEEN-MINUTE INTERVAL DEMAND-RECORD CHART

Off-Peak and On-Peak Demands

Realizing the ability to supply a heavy load at certain portions of the day (for instance, in the early morning hours when few lights are burning or electric cars running) and the inability to supply this load in the evening hours, some companies have separate rates for maximum demands drawn during their peak-load hours and during their off-peak hours. For instance, the power contract may read "$36 per year for each kilowatt demand used during the peak hours of 6 p.m. to 10 p.m. and $24 per year per kilowatt demand at any other portion of the day." Obviously, the result is to discourage power use during the peak-load period, thereby resulting in a more uniform 24-hour load for the generating machinery. In other cases a still lower rate is offered to fill the valley in the load curve; certain industries (for instance, ice-plants and garages, the latter charging electric cars) find it profitable to take advantage of the lower rate.

Measurement of Maximum Demand

If the installation is too small to afford a special meter, the maximum demand may be taken with an ordinary indicating wattmeter at a time when it is assumed that there is a maximum load on all the motors. This is assumed to be the maximum demand of the plant and is charged accordingly.

Another way is to take the demand direct from the watt-hour meter. To do this, observe the time required for a certain number of disk revolutions and from this figure out the demand. The formula for a meter whose disk constant is given in watt-seconds (as in a General Electric meter) is: $\textit{Watts demand} = \frac{3600 \times K \times R}{S}$, in which K equals the disk constant (generally marked on the disk), R equals the revolutions counted, and S equals the seconds for these revolutions. For instance, in a certain installation of a 15-ampere 500-volt, polyphase type D3 watt-hour meter, it was observed that 25 revolutions took 60 seconds. The constant K (marked on the disk) is 10. Therefore, working out in the formula, we get $\frac{3600 \times 10 \times 25}{60} = 14{,}166$ watts, or 14.166 kilowatts demand.

For Westinghouse meters the formula is $\frac{K \times R}{S}$ in which R and S have the same significance as before, but K is determined as follows: For all polyphase meters running at 25 r.p.m. full load $K = EI \times 4.8$, in which E and I are the volts and amperes marked on the name-plate.

Maximum Demand Meters

There are in general, six different classes of maximum-demand indicators:

1. The ampere-hour demand meter, employing the heating effect of the current to cause the air in a glass tube to expand and force a certain quantity of liquid into a suitable measuring tube. The measurement of the amount of this liquid determines the maximum demand in amperes, either alternating or direct current. This meter is now quite obsolete, although there are many still in use.

2. Watt-demand indicators such as shown in Fig. 1, employing an indicating dial, which is lagged by providing an escapement wheel and bar, which allows the indicating pointer to rise only as the disk revolutions work the escapement bar. Since the rate of escapement is proportional to the speed of the disk, and the final deflection is proportional to the watts passing through the meter, the final deflection is reached in a definite time without the use of clockwork.

3. Printing attachments to watt-hour meters, are auxiliary attachments using a circular paper disk or ribbon of paper for record. A contact on the watt-hour meter register closes at a certain number of revolutions of the disk, and this moves a cyclometer wheel forward one number in the attachment. At stated time intervals, a clock closes a contact, which prints this number and advances the ribbon.

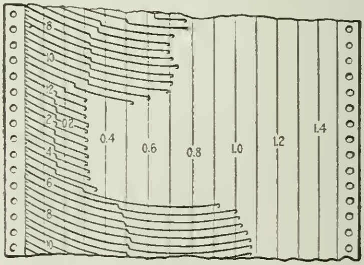


FIG. 5. THIRTY-MINUTE INTERVAL DEMAND-RECORD CHART

4. Graphic recording instruments are used extensively with these, it being merely a matter of picking out the highest point from the chart and integrating it with a planimeter.

5. Thermal-demand meters, such as shown in Fig.

2, are wattmeters actuated by the heating effect of the current, and the necessary time lag is given by providing sufficient thermal capacity to the pointer-actuating elements.

6. Combination watt-hour and demand meter, one type of which is shown in Fig. 3. This not only records the total watt-hour load, but also leaves a permanent, easily read record of the maximum demand and the time of its occurrence. The meter consists of the usual watt-hour meter element with a four-counter dial, and in addition a gear train which drives a pen across a chart at a speed proportional to the disk speed. At the end of each 15-min. interval, the clock advances the paper $\frac{1}{16}$ in., and if the meter is set to measure a 15-min. demand, it resets the pen, making a chart similar to that in Fig. 4. If set for 30-min. intervals, the advancing paper makes a little mark every 15 minutes, but the pen does not reset until the next period, thus making a chart like Fig. 5. A one-hour interval meter would have three notches in the curve before resetting.

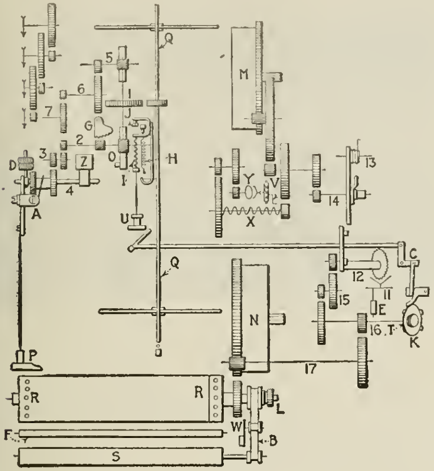


FIG. 6. SCHEMATIC DIAGRAM OF PARTS OF WATT-HOUR AND DEMAND METER FIG. 3

In Fig. 6 is shown the diagrammatic scheme of parts. The disk shaft *Q* registers watt-hours in the regular manner through the gearing 1, 5, 6 and 7. At the same time the pen *P* is driven by the gearing 1, 2, 3 and 4. When the clock trips, the tripping rod, pushing against *U*, moves the small pivoted framework which carries one of the bearings of shaft 2, and disengages the worm wheel of shaft 2 from the worm on shaft 1. This allows a counterweight *D* to swing the pen back to zero. When pressure on rod *U* is relieved, the spring *H* returns the worm into mesh and allows the pen to be driven forward again.

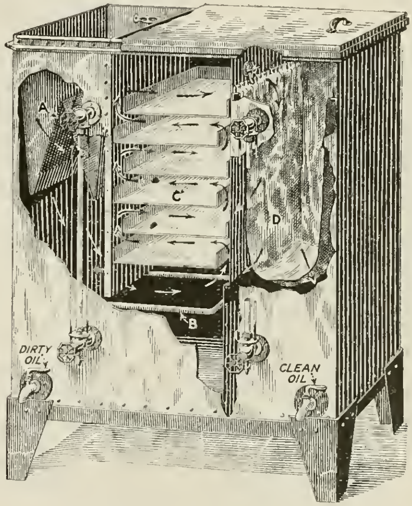
The spring *M* and the parts *X*, *Y* and *V* comprise an accurate 30-day clock. The special spring governor at *X* renders the clock isochronal. Each 15-min., the trip on shaft 14 allows 12 to rotate, power being furnished by spring *N*, and its speed is regulated by the escapement 11. This moves the paper on *R* and rotates the wheel *T* a quarter turn through shafts 15, 16 and 17. If the wheel *K* has four projections as shown, it will operate the tripping rod through the crank *C* at every trip, thus indicating the maximum demand at 15-min. intervals. If the wheel has only two projections, it will operate this rod every second time the clock trips, hence indicates 30-min. intervals, and if only one, then every fourth time, or 61-min. intervals. The main roll of paper is put on spindle *F*, passes over roller *R* and is rewound on the belt-driven spool *S*.

The meter should be mounted on a firm solid support, free from moisture, fumes or excesses in temperature or vibration. It requires only a little more attention than an ordinary watt-hour meter and gives very satisfactory results when used intelligently.

Bowser "Seven F" Oil Filter

In the Bowser filter no waste, bone black, fuller's earth, charcoal, excelsior or water is used in filtering the oil. There are but four operations performed, and these in the following order: Screening, precipitation of water, precipitation of solids, and filtering and storing of the clarified oil.

Referring to the illustration of the filter, which is made by S. F. Bowser & Co., Inc., Fort Wayne, Ind., oil is emptied into a removable strainer *A*, where pieces of foreign material are separated from it. The path of the oil is then around the steam coil *B*, up and around the precipitating tray *C*, and over into the filtering bag *D*, from which it runs to the storage base below it, from which the clear oil is withdrawn for use. Gage-glasses are provided for both the dirty and clean oil compartments.



SECTIONAL VIEW OF FILTER

The bonus system is used in a number of power plants. In one hydro-electric plant a bonus system for the hydraulic maintenance force is in use, by which the men receive extra pay for each day that they are able to decrease the actual time a certain machine is out of service for major overhauling, as compared with the schedule time.

LARGEST POWER PLANT AFLOAT

THE British battle-cruiser "Renown," which recently steamed out of New York harbor bearing Edward, Prince of Wales, homeward bound, is the largest war vessel ever seen on this side of the Atlantic. While quietly moored for about ten days within a few hundred feet of New York's skyscrapers, and known to be one of the "hush" ships constructed for the British Navy during the world war, she was the object of much interest and speculation with respect to her appointments of size, speed, armament and power plant. The "Renown" and her sister ship, the "Repulse," constructed at the same time and designed to be alike in every respect, were the largest and most noteworthy warships added to the British fleet during the war. Ordered from the Fairfield Shipbuilding and Engineering Co., Ltd., of Glasgow, early in January, 1915, the "Renown" was completed and placed in commission in the latter part of the year 1916. Her length between perpendiculars is 750 ft.; over-all, 798 ft.; extreme breadth, 90 ft.; draft, 30 ft.; displacement, 26,500 tons, receiving power by direct-drive from Brown-Curtis turbines driving four shafts, two each side of the ship. With these turbines developing 112,000 shaft horsepower the ship has made a speed of 32.6 knots, or better than 37½ nautical miles per hour. Although this propelling power is very much less than proposed for battle-cruisers for the United States Navy, the shaft horsepower of the "Renown" renders this vessel representative of the largest-sized power plants afloat. Steam is supplied from 42 B. & W. boilers. The fuel is entirely oil, and the oil-fuel capacity of the vessel is 4259 tons, or more than 28,000 bbls., exceeding the capacity of a tank 100 ft. in diameter and 20 ft. deep.

The vessel is minutely subdivided, having six boiler rooms and a cellular double bottom extending from the middle line right around the side and under the main deck. A longitudinal bulkhead, forming the boundary of the fuel-oil tanks, extends alongside the engine rooms, boiler rooms and magazines, with an inner bulkhead forming an air space for the extent of the boiler rooms.

The vessel has a very complete equipment, although the electrical equipment is not elaborate, especially compared with our electrically-driven ships. The electric generating machinery consists of two sets of steam-driven reciprocating engines, each of 200 kw.; one turbo- and one Diesel-engine-driven generators of equal power placed in separate compartments, forward and aft. There are electric ventilating fans for machinery spaces and for working compartments and living quarters, magazine cooling and ice-making plant; electric warmers; three sets of wireless installation; eight passenger elevators, for engine and boiler rooms, each carrying two men; electric power for driving workshop machinery; also the electric equipment in connection with fire control, telephones and alarm bells, transmission of range and training guns, danger signals, torpedo control and firing gear, and gyro-compasses. The capstan engines and cable holders are of the usual steam-driven type. Steam steering engines controlled by telemotors are placed on the after bulkhead in the engine room, and are connected up by shafting and gearing to a powerful set of screw steering gear for operation of a simple balanced rudder.

Like most British ships, this modern cruiser is not heated by steam, even the quarters that were occupied by the Prince of Wales depending mainly on stoves and fireplaces.

The Brown-Curtis propelling turbines are the largest direct-drive turbines built in the world. They are placed in two engine rooms side by side, divided by a middle line bulkhead. In each engine room are three turbines that drive two propeller shafts on the same side of the vessel, the high-pressure ahead and low-pressure ahead being on the inboard shaft and rigidly connected with each other, and the intermediate-pressure ahead turbine is on the outboard shaft. Incorporated in the same casing as the intermediate-pressure ahead turbine is a high-pressure astern turbine, and with the low-pressure ahead turbine is a low-pressure astern turbine.

The high-pressure ahead turbine consists of two wheels, each carrying three rows of blades, having a pitch-circle diameter of 10 ft. 6 in. The intermediate-pressure ahead turbine consists of two stages each of two rows of blades and a short drum of 12 rows of blades; then a second portion of two stages of two rows each; and a drum of 31 rows. The pitch circle diameter of these varies from 9 ft. 3 in. to 10 ft. The low-pressure ahead rotor consists of a drum portion of 34 rows, with a pitch-circle diameter of 12 ft. The last blades are 26 inches in length and 1⅜ inches wide. The astern turbines consist of two stages of four rows each and a drum of six rows forming the high-pressure astern turbine, and a wheel of three rows and a drum of nine rows forming the low-pressure astern turbine. The pitch-circle diameter of the high-pressure astern turbine is 10 ft. and of the low-pressure astern, 11 ft.

The propeller thrust in each case is nearly balanced by the steam thrust arranged in the turbine, so that no main thrust block is necessary, but only a comparatively small block on each line of shafting. Each of these blocks has a thrust surface of 4370 sq. in. on 16 collars. In order to obtain this balance in the intermediate-pressure turbine, one of the latest Curtis patents was introduced, namely, to take the steam a short distance along the turbine, passing it in the forward direction, and then, by external passages, to cause the steam to reënter the turbine and to travel aft for the remainder of the length of the rotor.

The shafts are hollow. The intermediate shafting is 18½ in. in diameter with an 11-in. hole, and the propeller shafts are 24 in. in diameter with a 19-in. hole. The shafts are cased with gunmetal liners in the stern tubes and main brackets.

The condensers, two for each set of engines, are placed in two compartments immediately aft of the main engine rooms, with the eduction pipes passing through the transverse bulkhead. The surface of each condenser is 19,225 sq. ft., or a total 76,900 sq. ft. for all the condensers. In the condenser room are the main circulating pumps, two per set of main engines, the evaporators, distillers, etc.

The main air pumps are in the main engine room, so as to be under the control of the engineer of the watch. The forced lubrication pumps for the turbine bearings are also in the engine rooms, together with the necessary oil coolers, filters, etc., and the smaller forced-lubrication pumps, coolers, etc., for the shaft bearings are in the condenser rooms.

As stated, steam is supplied by 42 B. & W. type boilers. They are entirely oil-fuel fired and are operated at a working pressure of 250 lb. per sq. in. The total combustion space of the boilers is 23,310 cu. ft., and the total heating surface of all boilers is 157,200 sq. ft., or more than 3½ acres. The boilers are all alike, each of 22 sections wide, 8 ft. 1 in. between headers. The bottom tubes are each 3 15/16 in. external diameter, and the remainder of the tubes 1 3/16 in. external diameter. There are two smoke funnels, the forward one serving 22 boilers and after one 20 boilers. The forward funnel is 25 ft. x 16 ft. 6 in., and is higher than the after one, which is 13 ft. x 16 ft. 6 in.

The Electrical Study Course—Synchronizing Alternating-Current Generators

How to determine with lamps when single-phase, two-phase or three-phase alternators are in phase, either with the lamps dark or bright at synchronism.

IN ORDER to operate two or more alternators in parallel, it is necessary that they be of the same voltage, of the same frequency, and that they be in phase. The first of these requisites is readily determinable by means of a voltmeter. To determine the other two, several devices are employed, as explained in the article, "Methods of Synchronizing Alternating-Current Machines," Sept. 16 issue. Of these the simplest is that in which two ordinary incandescent lamps are used to indicate when the correct condition exists.

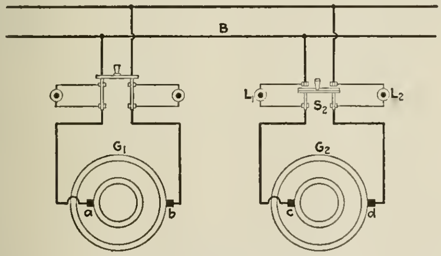


FIG. 1. CONNECTIONS FOR SYNCHRONIZING SINGLE-PHASE ALTERNATORS, LAMPS DARK

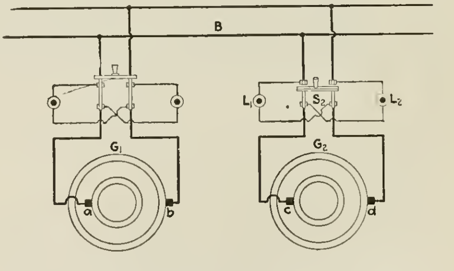


FIG. 2. CONNECTIONS FOR SYNCHRONIZING SINGLE-PHASE ALTERNATORS, LAMPS BRIGHT

In Fig. 1 we have two single-phase alternators, G_1 and G_2. Of these G_1 is connected to the busbars B, which lead to a load. Suppose that this load increases to the point where G_1 alone cannot carry it, so that it becomes necessary to put G_2 into service also. Having started G_2 and brought it up to normal speed, its voltage is adjusted to be the same as that of the mains. At switch S_2 lamps L_1 and L_2 have been connected in the manner shown. If these lamps do not light up, it is an indication that G_2 is running at the same frequency as G_1 and in phase with it. The machines are then said to be in synchronism. It is extremely rare that this condition exists without manipulation other than that described. Ordinarily it will be found that the lamps flicker. If the two alternators are almost at the same speed the flickering of the lamps can readily be followed by the eye; they will slowly light up to full brilliancy and then as slowly dim down to complete darkness, only to light up again. This will continue with perfect regularity so long as the speeds of the generators remain exactly as they are. Any change in speed, however slight, causes a change in the intervals of brightness and darkness of the lamps.

Having found that the lamps flicker, the speed of G_2 is changed slightly and the effect on the lamps noted. If the flicker becomes more rapid, it is an indication that the speed has been changed in the wrong direction. If it becomes less rapid, it is known that the speed is more closely approaching that of G_1. Finally, when there is no flicker it is proof that the two speeds are exactly the same. If the lamps are burning brightly when the flickering ceases, it is a sign that G_2 is 180 deg. out of phase with G_1 and that a short-circuit would therefore occur if S_2 were closed, even though the generators are running at the same speed. If the lamps are burning dimly, it is an indication that the machines are out of phase by some angle less than 180 deg., under which condition it is still not permissible to close S_2. When G_2 is in phase with G_1, the lamps remain dark. Thus, if they die down to darkness and then do not again light up, it is known that the two machines have been brought into phase and it is safe to close switch S_2, thereby connecting G_2 in parallel with G_1.

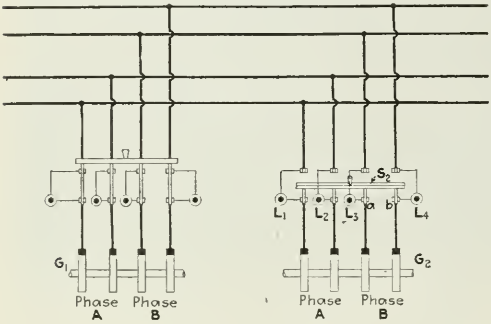


FIG. 3. CONNECTIONS FOR SYNCHRONIZING TWO-PHASE FOUR-WIRE ALTERNATORS

It is not usual to attempt to get the absolutely ideal condition indicated by the lamps not lighting up at all. Ordinarily, the speed adjustment is made until the lamps are flickering very slowly; that is, until it takes several seconds for the lamps to light up, dim down, and light up again. We know then that the speeds of the two machines differ only very slightly. The lamps are watched as they slowly grow dimmer and dimmer and finally become entirely dark. During this period and before they again begin to light up, the switch S_2 is closed.

Once connected to the bus B, the alternator G_2 must operate at the same frequency as that of the mains, for, as explained in the preceding lesson, alternating-current practice differs from direct-current practice, in that all the alternators connected to any one system must of necessity run at one and the same frequency. Hence, even though the speed of G_2 be slightly more or less than that of G_1, as soon as it is connected to the latter the two machines will fall into step.

Sometimes the lamps are connected as in Fig. 2; then the instant of synchronism is that at which the lamps are at full brilliancy—just the opposite from Fig. 1. This method has the advantage that if one of the lamps should happen to burn out, the fact will become manifest by the lamps refusing to light up under any manipulation of speed by the operator, and he will not be led to believe that the machines are in synchronism, as might be the case if the "dark" method were used. On the other hand, the precise instant of synchronism can be so much more readily judged in the case of the dark method, and the likelihood of an operator being deceived by the accidental burning out of a lamp is so slight that the "dark" method is in greater use than the "light" one.

The reason that the lamps in either method provide a guide is very simple. When terminal c of generator G_2, Fig. 1, is positive at the same instant as terminal a of generator G_1 and the voltage of the two machines are of the same value, then there can be no flow of current from one machine to the other, since the voltage of one machine completely neutralizes the voltage of the other so far as a circuit through the two machines is concerned. Therefore lamps L_1 and L_2 will not light up, indicating that the two machines have the same polarity. However, if terminal c is positive when terminal a is negative, then current can flow from c around to a through the armature of G_1 to b back to d and through armature G_2 to c, thus completing the circuit. It is seen from this that the same conditions exist as would if two direct-current machines of opposite polarity were connected through lamps L_1 and L_2; double potential of one machine would be applied across the lamps, and if they are for the voltage of one machine they will come up to full brilliancy, indicating, when connected as in Fig. 1, that the alternators have opposite polarity when the lamps are bright. In Fig. 2 if terminal c of G_2 is positive at the same instant as a of G_1, and the voltage of both machines is the same, then the two machines are in synchronism. However, in this case current can flow from terminal c of G_2 through L_2 around to b through G_1 to a and back through L_1 to d and through G_2 to c. Consequently, the lamps will burn bright when the machines are in synchronism.

The lamp method of synchronizing is not limited to single-phase generators, such as have so far been treated of. It is equally applicable to two-phase and three-phase synchronizing. Thus, in Fig. 3 we have two two-phase alternators, each of which has a phase A and a phase B. When the lamps L_1 and L_2 are dark, it is a sign that phase A of G_2 is in synchronism with the phase A of G_1. Similarly if L_3 and L_4 are dark the B phases are in step. It is evident that the connections must be so arranged that L_3 and L_4 are bright when L_1 and L_2 are bright and are dark when the latter are. Once the connections have been made so that such is the case, one set of lamps could be dispensed with. It is, however, preferable to keep both sets in service as a safeguard. For example, the leads of phase A on G_2 might become interchanged. Lamps L_3 and L_4 would then be bright when L_1 and L_2 are dark, and vice versa, and the mistake would become evident. If, however, lamps L_3 and L_4 had been removed, there would be no indication of the interchange. Moreover, using four lamps overcomes one of the arguments against the dark method; namely, that trouble might be occasioned through lamps showing dark, owing to one being burned out. Unless one in each phase were to burn out at the same time, there would always be one phase to judge by.

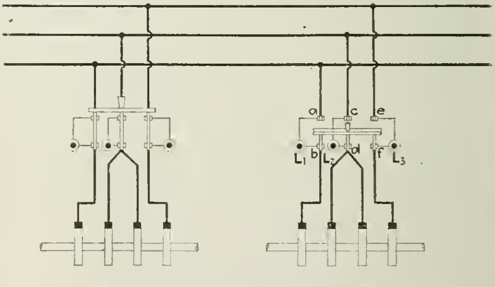


FIG. 4. CONNECTIONS FOR SYNCHRONIZING TWO-PHASE THREE-WIRE ALTERNATORS

In Fig. 4 are shown the connections for synchronizing two-phase generators when supplying current to a three-wire system. In this case the lamp at L_2 must be for a higher voltage than that of either phase, since the voltage across *cd* is, under normal conditions, equal to 1.41 times that across *ab* or *ef*.

The arrangement for a three-phase system is shown in Fig. 5. When correctly connected, the three lamps L_1, L_2 and L_3 will flicker in unison. If the connections have not been made correctly, it will be found that the lamps do not flicker in unison, and that as the condition of synchronism is reached, two of the lamps will be passing through a bright period while the third is passing through a dark one. Two of the leads must in that case be interchanged in order to make all three lamps indicate in unison. It is possible to synchronize three-phase generators by the use of two lamps instead of three, but the three-lamp method is preferable.

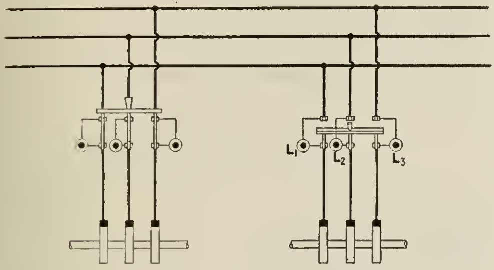


FIG. 5. CONNECTIONS FOR SYNCHRONIZING THREE-PHASE ALTERNATORS, LAMPS DARK

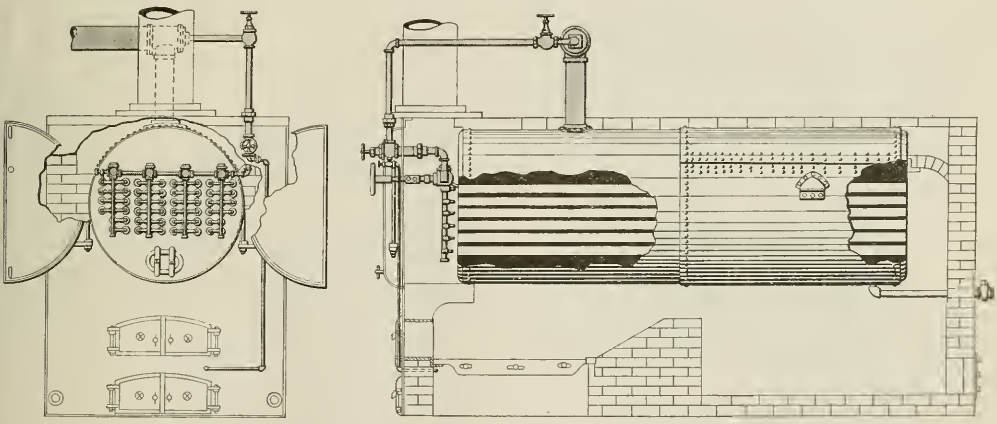
The problem of the preceding lesson stated that a polyphase wattmeter in a balanced three-phase system indicates 150 kw., that the load is connected delta and that ammeters in series with each load read 300 amperes and the voltmeters across them 220 volts. It was required to find the line current, the apparent power—that is, the kilowatt-amperes of the entire system, and its power factor. When a load is connected delta, the line current is equal to each load current times 1.73. Hence, line current $= 300 \times 1.73 = 519$ amperes. We know that apparent power in kilovolt-amperes $kv.a$ $= 1.73 \times E \times I \div 1000$, where E is line voltage and I line current. Hence, we have $kv.a = 1.73 \times E \times I \div 1000 = 1.73 \times 220 \times 519 \div 1000 = 197.5$ kilovolt amperes. The power factor is equal to the actual power divided by the apparent power, hence we have,

$$\textit{Power Factor} = \frac{kw.}{kv.a.} = \frac{150}{197.5} = 75.9 \textit{ per cent}$$

The common wire of a three-wire two-phase system carries 141 amperes. If the load is a balanced one, what is the current in the other two wires? If the phase voltage is 115 volts, what is the apparent power? If the power factor of the load is 88 per cent., what is the actual power? If the two outside lines each have a resistance of 0.00467 ohm, what is the loss in them?

Adriance-Bate Mechanical Flue Cleaner

The Bate mechanical flue cleaner is of the fixed-nozzle type and is built and installed to meet the demands and requirements of each individual boiler. It requires less than three minutes to blow the tubes, and the stream blast is controlled by valves on the exterior of the boiler, making it unnecessary to open flue doors to clean the tubes. The cleaner, owing to its construction, acts as a superheater for the steam used in cleaning the tubes. Condensation is taken care of by $\frac{3}{8}$-in. pipe fitted with a valve. The pressure entering the tubes passes through jets designed to create centrifugal force and high velocity. The apparatus does not interfere with the natural draft. The cleaner is removed if necessary by the disconnecting of one ground joint union without taking the cleaner apart.



ADRIANCE-BATE MECHANICAL FLUE CLEANER

The reinforced-concrete chimney, 570 ft. high and 26 ft. 3 in. inside diameter at the top, built at Saganoseki, Japan, was the subject of some investigations by Professor Omori as to the movement of the top when subject to wind pressure. Wind velocities were recorded ranging from less than one mile per hour to a hurricane velocity of 78 miles. The amplitude of vibration at a velocity of 50 miles per hour was less than one inch; at 78 miles per hour it was 7.32 in. The Maximum amplitude was in a direction at right angles to that of the wind.—*The Engineer.*

An Instrument for Measuring the Flow of Fluids

By CORNELIUS WEBER[*]

IN THE work of analyzing power plants and costs of energy a full knowledge is necessary of what is happening in the various pipe lines—especially the steam lines, both live and exhaust. To obtain this knowledge, steam-flow meters are pressed into service, and a graphic record, as well as a summation of the total quantity of steam flowing in a given pipe, is obtained.

The writer in his work has been confronted with the problem of steam- and other fluid-flow measurements, wherein it is necessary to take into account, not only varying pressures, but pipe characteristics as well, and where portability and adaptability to any size of pipe are of great importance, and where the instrument used may be connected or disconnected at will without interrupting the operation of the pipe in question. A careful investigation led to the conclusion that the well-known pitot tube offered a good solution, and the measuring outfit shown in Fig. 1 was designed. It consists of a universal pitot tube with a pressure gage and manometer to complete the equipment. The pitot tube itself consists of two ¼-in. brass tubes t, on the lower ends of which are attached the nozzles n shown. The brass tubes can be turned about their axes and can be moved in or out through the stuffing-boxes b by adjusting the yoke y up or down on the guide rods r, to which it can be secured by the winged nuts w, which serve to lock the yoke in position. Collars on the brass tubes secure the tubes to the yoke.

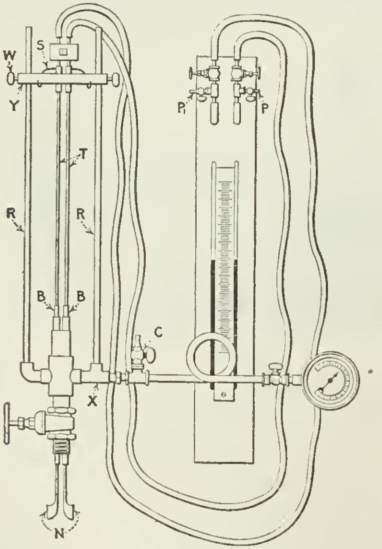


FIG. 1. INSTRUMENT FOR MEASURING FLOW OF LIQUIDS

The upper collars have notches cut in them, into which fingers on the ends of the springs s fit snugly, and these serve to hold the tubes from turning about their axes when measurements are to be made. The notches in the collars are so placed that when the fingers are in these notches the nozzles point in opposite directions in order that one nozzle may point upstream and the other downstream.

When the fingers are disengaged from the notches in the collar, the tubes and nozzles can be turned and the nozzles fold upon each other, allowing the latter to pass with ease through an inch pipe or gate valve. The upper ends of the brass tubes communicate through high-pressure air hose with a manometer inclosed in a wooden frame into which slits have been cut to make the two legs of the glass U-tube, inclosed within, readily visible. A differential scale, with a runner, pointer and hair line, makes accurate reading of the liquid column in the glass tubes possible.

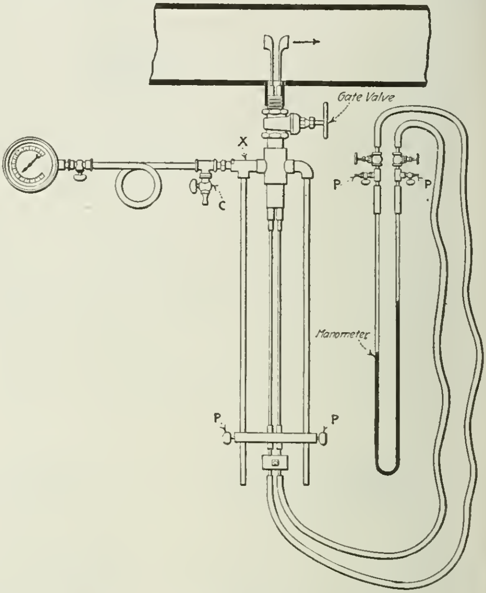


FIG. 2. DIAGRAM OF THE OUTFIT ATTACHED TO PIPE READY FOR USE

The steam-pressure gage is attached at the point marked x. When meaurements are to be made, a one-inch nipple and gate valve are attached to the pipe in which it is desired to make a flow test. The pipe and gate valve are put on by the operators of the power plant, upon instructions previously issued, and must of necessity be done on Sunday or after shutdown. Several such taps in various pipes may be made for various measurements, for the instrument can be attached or detached at will.

With the nozzles folded upon each other, the instrument is screwed to the gate valve, as shown in Fig. 2. The gage and siphon are attached at x, and the small gage-cock c is opened. By means of a rubber bulb and hose, water is injected into the hose through the pet-cocks p until all air is expelled and solid columns of water communicate between the nozzles and the mercury or other suitable liquid in the manometer. The various cocks are closed, and the gate valve is opened entirely. The nozzles are now pushed into the center of the stream flow and turned in such manner that one points upstream and the other downstream, whereupon the liquid column in the manometer will deflect.

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[*] With Vaugh & Meyer, Milwaukee, Wisconsin.

The velocity of the steam or other liquid can be determined from the well-known fundamental formula, $V = \sqrt{2\,gh}$, where V represents velocity in feet per second, h the deflection in feet of the given substance to be measured, and g the value 32.16, the acceleration of gravity. From the velocity obtained and the density of the substance, as well as the pipe cross-sectional area, the quantity flowing per hour can be determined. In a practical measurement it is, of course, necessary that readings be taken continuously, and the time, pressure and manometer reading noted whenever a change in deflection or pressure occurs. It is also necessary to make a traverse across the diameter of the pipe, to determine the ratio between the average velocity and center velocity to arrive at the pipe constant.

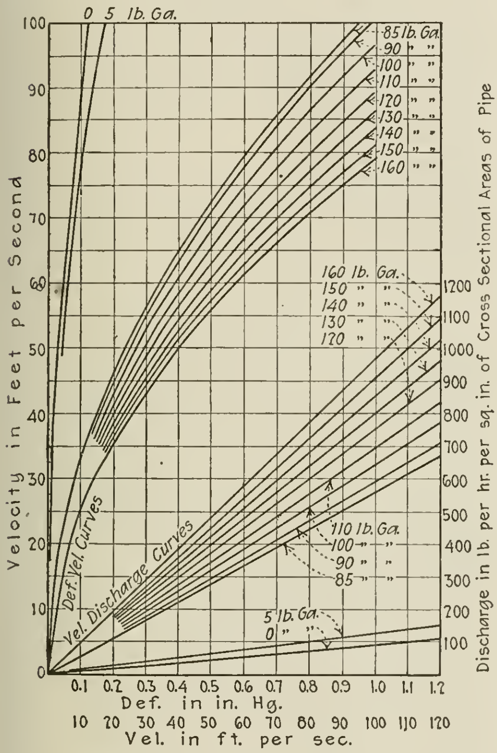


FIG. 3. CHART FOR USE WITH THE FLOW-MEASURING INSTRUMENT

The instrument has been carefully calibrated by condensing and weighing the steam measured, and it was found that it has a well-defined constant of about .84; that is, the formula $V = 0.84\,\sqrt{2\,gh}$ applies to the instrument itself. Evaporation tests made on boilers, steam-consumption tests on engines, and heat balances have been made with this instrument with gratifying results.

The tedious process of calculations has been minimized through the curves developed and shown in Fig. 3. These curves have been worked out for a pipe constant of 0.9. From a given deflection and pressure reading, the velocity is found at the left, when deflection is noted at the bottom. Transposing the velocity so found at the left to the other scale at the bottom, the flow in pounds per hour per square inch of cross-sectional area is read at the right. Consulting a table of pipe sizes, the actual flow is readily determined.

As an example, let it be supposed that in a standard 5-in., pipe under 100-lb. pressure, a deflection of 0.3-in. of mercury is to be interpreted. The value 0.3 is sought at the bottom and the vertical line followed until the 100-lb. deflection-velocity curve is intersected. Reading to the left of this intersection, the value 52.5 ft. per sec. is found. Taking the value 52.5 at the bottom and following the vertical line until it intersects the 100-lb. velocity-discharge curve, it will be found by reading to the right of the point of intersection that 335 lb. of steam is flowing per hour per square inch of pipe area. Multiplying 335 by 20, the pipe area, it will be found that there is flowing 6700 lb. of steam per hour.

The instrument can be used on any size of pipe and will measure air, gas, oil or water with the same facilty with which it measures steam. The density of must, as a matter of course, always be taken into consideration.

Superheated steam at 150-lb. gage with 150-deg. of superheat has been measured with this instrument and with entire satisfaction, and the writer feels that the disadvantage of the necessity to take readings at short intervals is offset by the many other advantages that it possesses, for it can readily be carried from place to place and quickly installed. The absence of moving parts and mechanism and its general simplicity make for accuracy and reliability.

Ice Plant as Nuisance

By A. L. H. Street

A court decision disclosing the attitude of the courts in case where operation of a mechanical industry interferes with the enjoyment of near-by dwelling places was handed down recently by the New York Supreme Court in Brooklyn, in the case of Robb vs. Rubel Bros., Inc.

It is found that the defendant's artificial-ice plant, operated on premises adjoining the plaintiff's apartment building, resulted in reducing the value of the plaintiff's property from $12,000 to $8000. Accordingly, the court orders that unless the defendant reimburses the plaintiff against this loss, an order permanently enjoining further operation of the ice plant will be entered.

The plaintiff is held to be entitled to legal relief on a showing that the plant had been operated under such circumstances as to amount to a nuisance. The work was carried on night and day. The operation of the machinery caused constant vibration of the plaintiff's building. The handling of ice and ice tanks produced unceasing noise. Use of the ammonia condenser on the roof of the plant resulted in the projection of sprayed water against the wall of the plaintiff's building, keeping it in a constant state of dampness.

Engineer's Tool List for a New Plant

By JOHN A. STEVENS
Consulting Engineer, Lowell, Mass.

When fitting out a new power plant with tools and supplies, you are sure to leave out many things you do not want to omit. Here is a list compiled by Mr. Stevens, one of the country's well-known engineers. It is a list you will want to keep handy.

Office Equipment

One roll-top desk for engineer, medium size, sanitary base.

One small flat-top table with drawer for engineer's office.

One small bookcase or section for top of desk.

One clock in the station, Western Union connected clock preferred.

Telephone from power station, connected to the necessary departments, or switchboard of the company.

Complete engineer's log and necessary stationery.

One emergency medicinal kit.

One-gal. jar limewater and linseed oil for serious burns which the operators may receive.

Ten lb. white flour to use for burns in connection with the limewater and linseed oil.

Supply of towels and soap for engineer's lavatory, including ½ doz. cans flash or its equivalent.

Gross packages of toilet paper.

Gross of safety matches.

Pencils—black, blue, red and blue.

Box pen points.

Half-dozen pen holders.

Erasers—ink, pencil and art gum.

Inkstand.

Rulers, 15-in., flat.

Box pins.

One box each of round and oval paper fasteners.

Rubber bands.

Tube of glue.

Jar of paste.

Stationery, including envelopes.

Blotters.

One large bottle black ink.

One small bottle red ink.

Time books.

One Ever-ready electric lamp.

Instruments

Instruments located in boiler room and switchboard gallery:

Portable Orsat.

One portable steam meter with one plug each 2- to 12-in. pipe sizes.

One portable voltmeter.

One portable ammeter.

Tachometer.

Stop watch.

Barometer.

Hayes recording flue-gas apparatus.

Time clock.

One salimeter or hydrometer, if plant is located where brackish water is used.

One deadweight gage-testing equipment, complete with gage-pointer puller.

One air compressor of at least 100 ft. capacity, to deliver air at 110 or 120 lb.

Two air-pressure gages (U-gages).

One engineer's transit and level combined, and rod.

Instruments—Continued

One dozen pencil thermometers for recording temperatures from 20 deg. below zero to 750 deg. F. These in assorted temperature ranges as required.

Flue-gas thermometer.

Set of steam-engine indicators with springs, 8 to 100 lb., for each indicator if engines are used.

One 500-lb. test gage.

One 30-lb. test gage.

One vacuum-test gage.

One 250-lb. test gage.

One thousand indicator cards, if steam engines are used.

One thousand sheets for each kind of recording instrument used.

Six hanks of indicator cord.

Tools

Chisels: Complete set of flat chisels and cape chisels; complete set of carpenter's woodworking chisels and gouges.

Calking tools.

Crowbars: One 3-ft. crowbar, or spud bar; two 5-ft. crowbars; one pointed pinch bar; one flat pinch bar.

Drills: One ratchet and complete equipment of twisted drills from ½-in. to 1-in.; one breast drill with complete equipment of drills; one chain drill, hand-operated; one electric drill; one air drill and complete set of chisels; one drill press that will handle drills up to 1½-in.

Files: Two dozen assorted files, with handles for them, including all sizes of round files.

Hammers: Two machinists' hammers; two carpenters' clawhammers; two coal hammers; one 4-lb. sledge; one 20-lb. sledge; two copper or lead hammers; one blacksmiths' anvil; air hammer.

Jackscrews: One 50-ton hydraulic jack; two 8-in. common jackscrews; two 24-in. common jackscrews.

Levels: Carpenters' level and high-grade machinists' level.

Machine tools: One 15-in. engine lathe; one small shaper with the necessary cutting tools supplied; one blacksmiths' forge.

Planes: One small hand plane; one large hand plane; carpenters' draw shave.

Pliers: Three sizes of multiple lever or fulcrum pliers.

Rope: 50 ft. of ½-in. rope; 50 ft. of ¾-in. rope; 100 ft. of 1-in. rope; six balls marlin; one dozen balls strong linen string.

Rope and chain falls: One set of 3-ton chain falls; one set of 1-ton chain falls; three grab chains, made with ½-in. stock in the links with a ring in one end and a grab hook in the other 6 ft. long; one set of 4-in. blocks for inch rope; one set of 4-in. sheave rope falls for ½-in. rope; six rope slings, supplied and made ready for use, of miscellaneous lengths.

Engineer's Tool List for a New Plant—Continued

Tools—Continued

Saws: Carpenters' rip saw; crosscut saw.

Screwdrivers: Two 6-in. screwdrivers; two 12-in. screwdrivers; two 24-in. screwdrivers.

Shears: One bench-mounted shear; tinsmiths' shear.

Soldering equipment: Solder and soldering equipment for soldering irons; electric soldering iron; 25 sheets of tin; two sheets of copper; spelter, muriatic acid or other equipment.

Taps and dies: One complete set of Greenfield taps and dies, supplied in cases; one complete set of pipe dies from ¼- to 6-in., hand-operated.

Vises: One 6-in. vise; one 6-in. pipe vise; one small pipe vise that will handle pipe from ¼-in. up in the small sizes.

Wire and cable: Ten pounds copper wire, miscellaneous sizes; 50 ft. ⅝-in. wire cable.

Wire cutters: One multiple-lever wire cutter.

Wrenches: One complete set drop-forged wrenches in sizes from ⅜-in. standard nuts to 3-in.; two 6-in. monkey wrenches; two 12-in. monkey wrenches; two 24-in. monkey wrenches; two 6-in. Stillson wrenches; two 14-in. Stillson wrenches; two 36-in. Stillson wrenches; two adjustable-jaw spanner wrenches with "S" handles.

Any other special wrenches that are required to fit nuts or bolts which are in a difficult position to reach with standard wrenches (such as crow-foot wrenches or especially forged ringed spanners).

"Favorite" reversible ratchet wrenches as follows: One 15-in. handle and one head with openings for ¼-in. and ⅜-in. square nuts; one set sockets to fit head consisting of one 8-in. extension socket; ten sockets to fit standard nuts, square and hexagon, ⅜-in., 7/16-in., ½-in., ⅝-in. and ¾-in.; one extension; one drill head.

One 15-in. wrench with heads A, B and C; one 28-in. wrench with heads D, E, F, G and M.

One steel straight-edge and two other straight-edges, one 6 ft. long and one 10 ft. long (made by carpenters on the job of clear stock, dry white pine); one putty knife; one 100-ft. steel tape.

Boiler and Turbine-Room Supplies

Complete set of firing tools.

Supply of boiler handhole and manhole gaskets.

Several spare manhole and handhole yokes.

Coal supply for at least three months.

If common furnaces are used, 3 sets of furnace-door mouthpieces.

Six furnace-door liners.

Three thousand firebrick of all grades.

Two cubic yards of fine clean sand.

Dozen bags of fireclay.

Dozen bags of portland cement.

Two barrels of lime.

—— feet of air hose.

Gage glasses: One gross water-glass gage-glasses for the boilers; one dozen of all other gage-glasses used in and about the station and its equipment; gage-glass washers; washer cutter.

Masons' tools: Half dozen masons' trowels; smoothing trowel; one mortar bed.

Shovels: Dozen No. 4 scoop shovels; three square-nosed shovels; three round-nosed shovels for digging.

Packing: Ten yards "Permanite," "Durabla" or other asbestos packing; 10 yd. 1/16-in. "Rainbow"; 10 yd. ⅛-in. "Rainbow"; 2 yd. 1/32-in. "Rainbow"; 1 dozen balls "Palmetto" packing; 50 ft. each type Tuppers flax packing; 50 ft. each type flax packing from ¼-in. to ¾-in., if used in plant; 100 sets packing for condenser tubes; 2 dozen balls candle wicking; 1 set packing hooks.

Plugs: One dozen extra fusible plugs for boilers.

Tubes: Twenty-five spare condenser tubes; 20 spare tubes for the main boilers; 5 superheater tubes for the main boilers; if plunger feed pumps are used, complete set of feed-pump valves; if engines are used, spare set of crankpin boxes or crosshead boxes; one tube-boring equipment; tube expander that will expand any tube in any boiler, or 2 tube expanders, if necessary.

Miscellaneous

Half dozen sprinkler heads, high and low-pressure, if used.

Complete set of oil cans, including oil squirt cans and fillers.

Complete set of oil torches or open lamps, if station is electrically illuminated for emergency use when main current is off busbars.

Twelve sperm candles.

Two globe lanterns.

Two dozen corn brooms.

Two dusting brushes.

Square yard brass wire gauze.

One dozen galvanized iron fire pails to be used for miscellaneous work about the station.

—sheets of galvanized iron.

Bar iron: Miscellaneous bar iron, clamps and bolts from 6-in. to 10-in.; round iron from ¼-in. to 1-in., in miscellaneous lengths; ½ dozen lengths of bar iron from ¼ x 1 to ⅝ x 3 in., one bar each size; stock of pipe of all sizes used.

Bolts: 100 assorted bolts, nuts and washers; complete set of I-bolts, same with standard threads from ⅜ in. to 1 in.

Flanges: One pair flanges each, 2 in., 2½ in., 3 in., 4 in., 5 in., 6 in., 7 in. and 8 in. standard drilling.

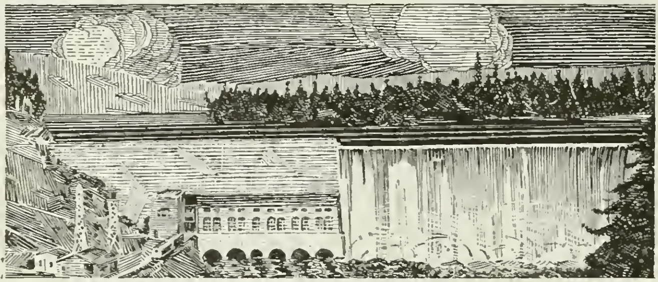
Ladders: One stepladder; one 12-ft. common ladder; one 20-ft. common ladder.

Nipples: Full assortment of pipe nipples from ¼-in. to 3-in.; close nipples and 3-in. nipples, ¼- to 3-in.

Valves: Piston rings and valve stems of every size (at least one spare valve of every size of valve used in station with the exception of feed valves, of which there should be at least two, and blowoff valves, of which there should be at least two); extra pilot valve for damper regulator, if any; extra valve disks, if this type of valve is used.

Oil: Complete supply of all oils used; barrel of kerosene oil; four 50-lb. kegs of red lead; four 50-lb. kegs of white lead; can of graphite; 5 gal. linseed oil.

Every tool and instrument stenciled, stamped or marked with the corporation's name and charged against the chief engineer upon taking charge and charged off against his account when leaving the employ and recharged to the new man entering the employ. Appraisal of this equipment taken with the main equipment each year and the stock and equipment kept up as though the equipment were a part of the main units.



POP'S WATER-POWER COURSE

By
John S. Carpenter

JIMMY waited patiently until Pop had negotiated a generous chew from his plug. "You were going to tell us what the lecturer said about finding the entrance and discharge angles and some other stunts."

"Gimme that paper an' them pencils," Pop commanded. "Now glue yer lamps to Fig. 1. This is the same wheel we've been figgerin' with at our last talk, with a ratio of 9 and a velocity percentage of 58 on the outside of the wheel. In our doin's with the Francis turbine you remember the law I gave you, the law for efficiency, 'Entrance without shock and discharge without velocity.' When we considers Pelton wheels, the law still holds good. To git the entrance angles, you lays off the velocity of the jet to any convenient scale, which is *V* in the figger. Then you does the same for the wheel velocity, only you lays it off tangent to the wheel at the place it strikes. You see that the jet particles don't strike the wheel at the same place as I shows you on sections *A*, *B*, *C* and *D*. That don't mean that the water particles has different velocities, but that they strikes the wheel at different angles. Then completin' the parryllelogram, you gits the direction of the relative velocity of the water. Now, as I told you when we was tryin' to git the angles for the Francis turbine the water must follow that relative direction or they is shock. In the sketch I shows them angles with respect to the radial line.

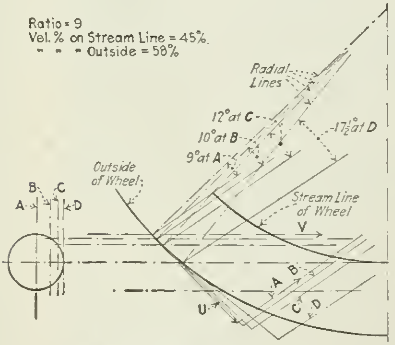


FIG. 1. ENTRANCE ANGLE AT ENTERING LIP OF BUCKET

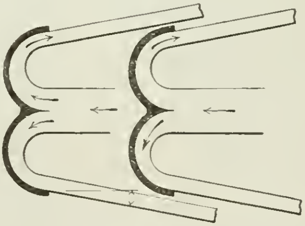


FIG. 2. DISCHARGE ANGLE OF THE WHEEL BUCKET

"In the good old days long ago they didn't attempt to make diagrams to find the correct angles for the buckets and you often saw buckets that had been runnin' only a short time with the backs all eroded and eaten out. It was a case of shock on the stream so that the water entered the bucket with a good deal of splash. I don't have to tell you this condition causes loss of efficiency."

"Pop," inquired Jimmy, "supposing that the back of the bucket where the stream strikes was cut back sharp enough so that the jet cleared it at all points, would you still have loss?"

"Yep. Theoretically, the water must flow parryllel to the relative velocity or they is shock. The jet is turned too sharp inside the bucket if the back is cut back to clear like you said, an' the water is slapped outa the path of the jet by havin' the back too blunt. In the first case you're liable to git wearin' away of the bucket on the inside and erosion on the back side, 'cause on the inside the water comes into violent collision with the bucket an' outside air gits between the jet an' the bucket back an' chemical action goes on."

"You're getting to be great on elucidating these mysteries," flashed Jimmy in admiration.

"Now, as for the discharge angles, they isn't any hard an' fast rules. Like the guy which invented the proverb, 'Whaddle you have?' an' got famous on that one line, they was once a designer which come near gittin' famous for dopin' out a way to git the discharge angles. Only, when he come to think it over he sees thet he had to make so dern many assumptions that all his beefin' about accuracy was drowned out."

"Well, how do they do it, then? Why can't it be done accurately?"

"First, it's a hard matter to tell jes' how the water discharges out of the bucket. You has to guess at it, an' it's tall guessin' at that. Second, you don't know how thick the sheet of water is that comes outa the bucket, an' it varies in different positions of the bucket with respect to the stream. Take a squint at Fig. 2. The designer I was referrin' to is a purty decent feller, outsida that he figgered the sheet of water to be of the same thickness along the discharge edge, which ain't so, it bein' more or less like a triangle with the high point in the middle. So by the time you makes all them there assumptions you might jes' as well shoot craps to get the angle, the best three outa five winnin'."

"Now then, tell us how a regular guy does the trick!"

"I said in one of our precedin' talks that they made a few thousand tests on a lotta different styles of Pelton wheels in Europe and they went into the subject of discharge angles purty deep. From this dope we is told that they uses about 10 deg. on wheels which has a low ratio, or a big jet in proportion to the wheel, taperin' gradual-like down to about 5 deg. for large-ratio wheels.

"One or two degrees or so different one way or another on a given size wheel didn't noticeably affect the efficiency, even when it was purty clear that the water was strikin' agin the back of the followin' bucket. The fellers that run them tests, however, says that in case very small angles is used it is better to machine the edges of the backs of the buckets so the water doesn't strike on a rough surface, which would cause extry friction."

Jimmy nodded as if something was worrying him. "Say, Pop, if there was a case where a Pelton wheel was carrying a very irregular load, like, for instance, a sawmill or something, and the wheel was under pretty high head, whenever the load went off the wheel would speed up considerably in spite of any governor and parts of the jet slip through the wheel. Those jets would tear the daylights out of any setting you could build, wouldn't they?"

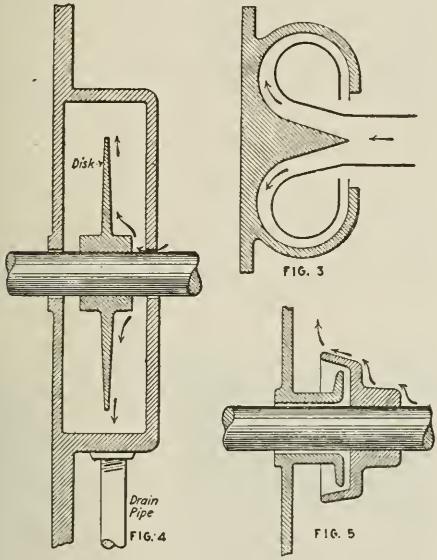


FIG. 3. ENSIGN BAFFLE PLATE. FIG. 4. CENTRIFUGAL DISK. FIG. 5. DOBLE WATER GUARD

"Yep, they would." Pop thought for a minute. Then he started to draw Fig. 3. "This is the thing the lecturer told us they used on high-head plants out West. It was invented by a man named Ensign, and the patents is owned by the Pelton Waterwheel Company, I understands. The idee is that the jet splits itself on that sharp splitter and then it goes around so dern fast thet it gits dizzy and finally falls out at the bottom into the tailrace water. The splitter is always set vertical and they gen'ly is a top to it so the water don't go upwards when it splashes onto the critter. Bein' as how the thing is patented, the other firms is outa luck in usin' it on their plants, so they uses somethin' like a baffle plate so placed that it catches the water on an angle an' then guidin' it down into the tailwater."

"That's quite clear to me. Now tell us how they proportion the size of the tailrace."

"That's simple," Pop commented. "A tailrace, to be any good, must be large enough to carry off the water without lettin' it back up and flood the wheel. Then it should be wide enough so a man that has et three square meals a day can git inside of it an' work around the buckets, inspect them and see how the nozzle is. Don't git the idee you can do it through a 11 by 16 manhole, either. You might jes' as well try absent treatment."

"That's fine, but how about velocities?" insisted Jimmy.

"The velocity shouldn't be more than about 2 ft. per sec. and the bottom of the tailrace should have a slope of about 1 ft. in twenty. That'll keep the water movin' purty good."

"Now tell me something about the housings for Pelton wheels."

"I can tell you jes' as well what Paris is gonna give us next year in styles for the dear girls. They's all kinds of arrangements and styles. Some is all cast iron, some is half masonry and half cast iron, some has the part above the shaft made of flanged steel plate, others has the whole dern thing made of steel plate an' so on. I thinks I guesses purty close when I says it depends on what the purchaser looks like he can pay."

"Plenty of variety then, I see. I suppose they have stuffing boxes on the shaft to keep the water from leaking out, don't they?"

"No. They don't use stuffing boxes. They is too many cases where the water carries sand an' grit an' which gits into the packin' an' scores the shaft. The only trouble with water leakin' out is when the wheel starts and water may be driven out if they is no guard there. Now see Fig. 4. This is a disk fastened to the shaft and rotatin' in a pocket. Whatever water may git into that space is caught on the disk and shot off by centrifugal force into the pocket below, an' the drain pipe takes it to the tailrace. This critter is the centrifugal disk, patented by the Peltron Waterwheel Company.

"They is another thing which works about as good as the Pelton disk. I shows it in Fig. 5. This works on about the same principle as the other. The water is caught on the disk and thrown radially out of the way. This device is called the Doble water guard, an' when the waterwheel business and patents of the Abner Doble Co., of San Francisco, was absorbed by the Pelton Waterwheel Company, this riggin' was used on some of the Pelton plants.

"An' now, son, with this part we closes the matter of Pelton wheels, after which we'll take up speed regulation, a mighty deep subject."

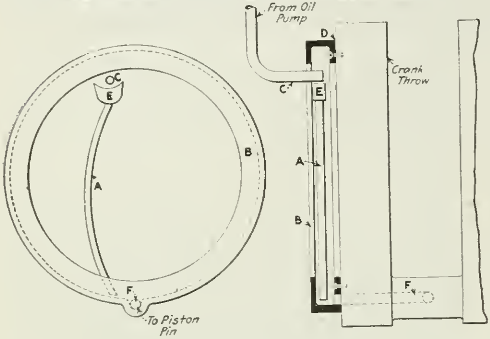
Where breaking of a piston ring caused a piece thereof to become lodged under a valve, resulting in the piston making a violent movement and causing injury to an employee, the employer is liable if it can be shown that the piston ring was badly worn before the accident and that the foreman in charge knew of that fact long enough to have permitted repair of the defect before the accident occurred. (Springfield, Mo., Court of Appeals, Yarborough vs. Wisconsin Lumber Co., 211 Southwestern Reporter, 713.)

Lubricating Oil Not To Blame

By L. H. Morrison

Frequently, after using any given lubricating oil on an oil engine, difficulty is experienced if a change is made to another oil. Many times the second oil gets an undeserved bad reputation in a plant. Recently, I went through such an experience that for a time was quite a puzzle. The unit was a Bohinder vertical hot-ball engine which was in poor condition. It was necessary to keep it in operation, and the crankpin bearings were burning out about every third night.

Investigation revealed that for some time a heavy valve oil had been used as a cylinder and bearing lubricant. This oil, while unsuited for use in an oil engine, apparently had been serviceable in this particular engine. This was due no doubt to the large clearances which the heavy valve oil served to reduce. Being in the Tropics, remote from oil stock, the supply of valve oil had become exhausted, and a few barrels of a fairly well-known Diesel lubricating oil had been purchased at a local station.



SHOWING THE OILING CONNECTIONS

The writer found that this oil had not given service, causing, as already stated, ruined bearings about every third night. Feeling that the oil, while suitable for a Diesel, might possibly be at fault, a barrel of oil especially adapted for use in this particular make of engine was secured. The bearing trouble was not reduced, and it appeared for a while that the oil had received a set-back in that plant.

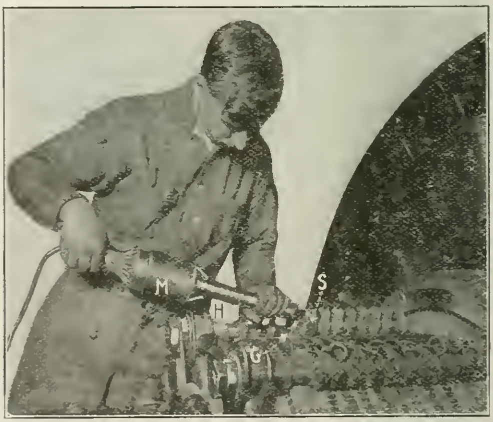
Upon thoroughly overhauling the engine, it was discovered that the oil was blameless. The crankpin was lubricated through a centrifugal ring, as appears in the sketch. The oil pump delivered the lubricant through the pipe *C*, which discharged it into the cup *E*, whence it flowed through the pipe *A* into the ring *B*. This ring allowed it to flow through the passage *F* to the crankpin. The cup *E* had become slightly misplaced, having shifted to the left. The valve oil was heavy and, as it left the end of the pipe *C*, dripped down into the cup and to the crankpin. The lighter Diesel and semi-Diesel oils, since they flow more freely, issued from *C* with enough velocity to completely miss the cup *E* and ran down between the oil ring and the crank-throw at *D*. Little oil reached the pin, and of course the babbitt overheated.

By shifting *E* to its proper position and bending the end of the pipe *C*, the oil was forced to enter *E*. Having done this, no more bearing trouble was encountered. Frequently, lubricating oil is condemned when actually the fault lies in some maladjustment of oiling devices.

Portable Tool for Undercutting Commutator Mica

Three features in the modern direct-current machine stand out as the most important for sparkless commutation and therefore satisfactory operation, namely, commutating poles, brushes of proper characteristics and undercutting the commutator mica. High mica in commutators has probably caused more operating troubles with direct-current machines than any others that commutators are subjected to. So well recognized has this fact become that many electrical manufacturers are undercutting the commutator mica before putting their machines on the market.

Undercutting mica must be done with some kind of a tool, of which many have been developed, ranging from a piece of hacksaw blade fastened in a wooden handle to power-driven machines used in large repair shops and armature departments of large electrical manufacturing companies. The illustration shows a portable tool for undercutting mica, known as the Aurand commutator slotter, and has been placed on the market by J. H. Green & Co., Chicago, Ill. This tool is a hand-operated power-driven machine, the essential part of which consists of a 1½-in. circular saw *S* keyed to a hollow mandrel, on which is mounted a worm gear. The hollow handle *H* contains the steel driving shaft with a worm and a small universal motor *M*. Immediately behind the saw travels a thin metal guide shoe *G*, which slides in the slot, thus insuring a straight cut. Adjustments are provided so that the machine is serviceable for any size of commutator and will cut to the prescribed depth. The saws are of different thicknesses to take care of all commutators. Mica in different commutators varies approximately from 0.018 in. to 0.035 in. The rate of speed at which mica can be cut with this slotter depends upon the length of the commutator and the grade of mica, and upon the operator himself. On large machines from 20 to 30 in. per min. can easily be cut.

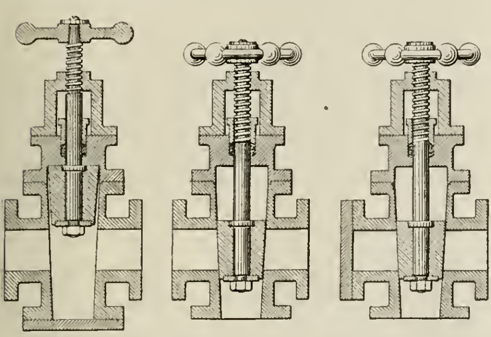


MICA UNDERCUTTING TOOL IN OPERATION

From the figure it is evident that the tool can be used without removing the brush rigging; therefore, the work can be done at a time when it is convenient to shut the machine down. The driving motor is of the definite-pole type, series wound, and is furnished for either 110- or 220-volt service, either of which will operate at 25 to 60 cycles.

Universal All-Service Valve

The chief characteristics of the Universal All-Service valve are that it can be used as a straightway, angle or three-way valve by simply changing a flange. The valve has a full opening as large as the pipe area, and a pocket is provided underneath the disk to catch any sediment or foreign matter that may enter the valve when it is in the open position. The flange under the seat can be safely removed while the valve is under pressure, but in the closed position, so that the foreign matter that has accumulated in the chamber under the seat can be removed. The disk is made round and tapered, and it never seats twice in the same place in succession. The illustrations show the design of this valve, which is perfected by the Universal All-Service Valve Co., Cleveland, Ohio.



SHOWING STRAIGHT-WAY, THREE-WAY AND ANGLE VALUES RESPECTIVELY

In large sizes, where a bypass is necessary, connection is made with the valve body to the bottom flange, and when pressure is equalized, opening this valve exerts the pressure on the bottom of the disk, which acts as a piston and assists in opening the valve. It should make an excellent blowoff valve, and when using two, as is the general practice, the danger of leakage should be practically eliminated as the seats are out of the flow and impinging of scale and other impurities does not harm them.

In case the valve stem breaks, it can be safely changed while the valve is under pressure by first shutting the valve, disconnecting the bottom flange and the top bonnet flange, when the new stem can be fitted in the valve body through the cone disk and after tightening the stem nut and replacing the flanges, the valve can be put back into operation.

Danny Hogan On Length Of Course Sheets

"I see be the *Power* paaper the editor do be inquiring why thim beaneaters in Mass. an' the highbrows on the biler-code comitty are limiting the length of a course sheet for horizontal return-tubular, vertical an' locomotive bilers," says Duffy, as he plied his dudeen at the Dutchman's.

"True for ye," said Doolin, "an' I'm glad ye read *Power* that close."

"Why," says Duffy, "do it be as it is?"

"Well," says Doolin, "after I get meself outside another scuttle of this 2.75 suds, I'll be telling ye the answer." The ceremony duly executed, Mr. Doolin relighted his ancient but mighty pipe and then resumed: "Ye should know, Duffy, of all biler explosions on record about the worst was those horizontal return-tubulars made wid one sheet on the bottom an' running from head to head wid two continuos seams lap-joint double-riveted from ind to ind, the seams bein' buried in the brickwork on the outside an' below the tubes on the inside. Bad enough to have lap seams, Duffy, but in these, wan had twice as much of thim and never could they be seen in practice.

"An', Duffy, I would again for the nth time, as the highbrows term it, remind ye that in them old happy days no one could make a sheet cylindrical at the ends when it was cold-rolled. So there was the flat place at each ind where the long seam would be, an' this was true of the early commercial butt-strapped bilers."

"What's a commercial biler?" asked Duffy.

"Well," said Doolin, "I hate to tell ye, but it was made to sell, wid rivet holes punched full size and costs rejuced as far as could be widout a strike. Be that as it may, the bald fact is the one-sheet-on-the-bottom H.R.T. beat the record in explosions. I have only a few in mind, such as the Detroit Journal wid 36 lives lost, the Penberthy Injector wid 29 lives, Swifts at Chicago, 13 gone, and many wid lesser cost of lives.

"Th' arguement advanced in making thim bilers was that the bottom was considered as a beam which would be weakened by cutting it in halves and riveting it together, making, say, a 52 per cent. joint. Also, it was thought good to avoid a girth seam in the fire. So the best of the shops fell for it utterly, neglecting the flat spot at the seams an' the springing of the rolls on long plates, the punching rivet holes full size, and the malicious drift pin and sledge of the lads doin' the riveting.

"An' ye want to know, Duffy, it's some job to take two troughs like the two halves of a 72-in. x 18-ft. biler and put them together to make a true cylinder, considerin' the 5-in. flat places at the edges. So 'tis no wonder they blew up since not bein' cylindrical, there was a constant bendin' action in an out at the long seams."

"So," says Duffy, "that's why they limit the length to 12 in., is it?" nodding to the waiter as he spoke.

"Well," says Mr. Doolin, "ain't that reason enough for what we made in the old days? But I'll tell ye if shops can make a biler widout the flat plate at the long seam, and I refer now to butt-strapped jints since the laps are out of style, there be no reason at tall why we can't make the plate 18 ft. or 24 ft. long. It depinds on special tools to work widout hurting the plate and to have no flat spot at the edges where the long seam do be.

"For meself I believe the plate mill should cold-roll the plates and have a big special ball roller to travel from end to end of the rolled sheet, that the flat section at the edge would be trooly cylindrical, and beyant that, the straps should be made at the plate mill and curved to the required radius, which be more and less than the biler shell. The thing of sledging straps in shape or trying to bring them about in shape by using a narrow, heavy piece of plate in the old rolls, belongs to the Jawn L. period, Duffy, an' is a rayson why the rules lay down on sheets over 12 ft. long for fire-tube bilers, tho' why they don't include water-tube bilers is no logic at all.

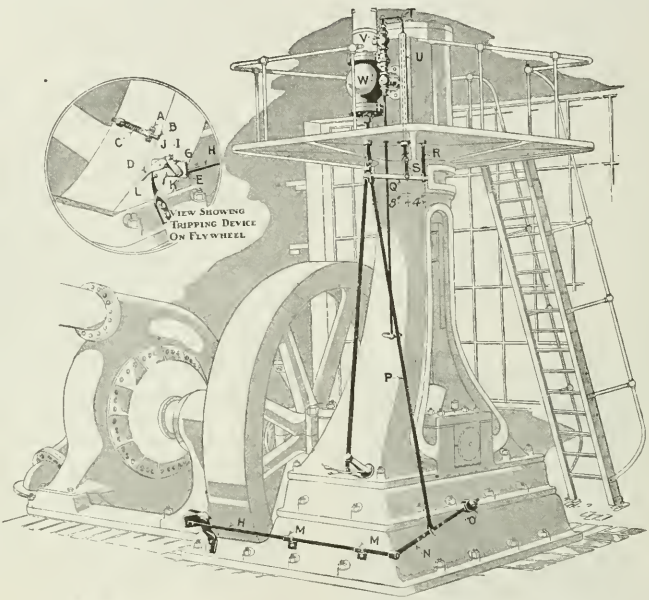
"I've seen as many bum jints on water-tube drums as on fire tubes when it comes down to brass tacks, an' eliminating the Bull of trade, the fire-tube biler can hold its own wid the best of thim. An' by the way, Duffy, why do so many of thim water-tube bilers explode by failure of the drum heads, and what do they be doin' to improve on this line? I'll ask ye that," says Mr. Doolin.

"Put it up to the paaper," said Duffy.

Home-Made Engine Safety Stop

Engines driving auxiliary units in a power plant should be safeguarded by some kind of safety stop. Many of them are not so protected, but in one instance at least the engineer designed a home-made safety stop and applied it to two vertical engines directly connected to centrifugal pumps that were used for providing condenser circulating water.

Attached to the rim of the engine flywheel is a casting *A* in the body of which is a pin *B* held in place by a spring *C* under tension so that the outer end of the pin does not protrude beyond the edge of the casting when the flywheel is running at normal speed. The tension on the spring is such that should the engine speed up a certain number of revolutions above normal, the centrifugal force exerted on the pin would overcome the tension of the spring and the pin will project beyond the casting sufficiently to strike the end of the latch *D*, which is pivoted on a bolt on the angle iron *E*, that is securely bolted to the engine bed, as shown at *F*.



HOME-MADE ENGINE STOP AS APPLIED TO A VERTICAL ENGINE

A dog *G* is secured to a shaft, and the projections *I* and *J* latch when the latch *D* is against the stop-pin *K*. The stop-pin *L* is to prevent the latch *D* from moving too far when struck and tripped by the pin *B*. The latch-pin *D* is 10 in. long, ⅜ in. wide and is made with an easy curved surface on the face side. The angle iron supporting the latch *D* and dog *G* is of iron 2½ in. wide and ⅜ in. thick.

The ¾-in. shaft *H* is supported at the opposite end from the angle iron *E* by two bearings *M* and carries ¾-in. diameter weight lever *N*, on the end of which is 4-in. diameter weight *O*. This weight lever is drilled with several bolt holes, through one of which the ½-in. rod *P* is attached. This rod connects to one end of a rocker rod *U*, which is pivoted at the outer end to a ½-in. round stud *R*.

About midway of the arm *Q* a short link *S* is loosely pinned at one end and connects to a vertical rod *T*, which is supported by a hollow stand *U* that is secured to the engine grating platform.

The engine was originally piped to a 5-in. steam line with an angle valve connecting with a steam chest by a short nipple. This pipe was found to be too large for the service required, and a 1½-in. angle valve *V* was therefore connected to the steam pipe above the 5-in. valve, and a second valve *W* of the same size, to act as a throttle valve, was connected to the first by a short nipple at one connection and the other to the 5-in. nipple connecting to the steam chest. The valve *W* was fitted with an extension valve stem convenient for the engineer to manipulate from the floor. With the latch *D* and the dog *G* latched, the valve *V* will be open, and with the valve *W* open the engine speed is controlled by the governor.

In operation the device works as follows: With the engine running at normal speed, the pin *B* does not project far enough beyond its housing to strike and trip the latch *D*, which is holding the dog *G* in a locked position. In the locked position the weight *O* is in its highest plane and the valve *V* is consequently opened. Should the engine speed up beyond a predetermined number of revolutions, the pin *B* is thrown out to a position that causes it to strike the latch *D*, which trips the dog *G* and the weight *O* moves the lever in a downward direction, which motion is transmitted to the valve *V* through the rod *T*, thus shutting off the steam to the engine. The engine cannot be started again until the latch *D* and dog *G* have been engaged in the set position. Every engineer doubtless realizes the danger that is present when an engine is operated without a safety device of some kind. The foregoing illustrates how easily an engine can be protected against overspeeding by making a home-made safety stop that is within the reach of all, is inexpensive to build and one that can be made by anyone possessed of a little ingenuity.

A contract whereby a power company agreed to perpetually furnish electric current to a manufacturer, in consideration of the latter's transfer to the company of power created by a dam was not abrogated by the subsequent enactment of the Illinois Public Utilities Act. A state may regulate the charges and business of a public utility furnishing power, so as to protect the public against unreasonable charges and unjust discrimination and to promote the public welfare, but an act purporting to abrogate vested rights, such as that acquired by the aforementioned manufacturer, would be unconstitutional as a deprivation of property without due process of law. (Illinois Supreme Court, Schiller Piano Co. vs. Illinois Northern Utilities Co., 123 Northeastern Reporter, 631.)

EDITORIALS

Real Co-operation

ONE of the fine things that the strike brought out was the spirit of appreciation of our difficulties and approval of our course expressed by our patrons, subscribers and advertisers alike. We have been unable to acknowledge these kind and encouraging messages individually, but take this means of assuring their authors of the satisfaction with which they were received, and the appreciation which they evoked on the part of all who have been concerned in formulating and carrying out the policies which they commend. A few excerpts from these letters follow:

> I do not know what your intentions are with regard to back numbers, but for my part I want to thank you for the way in which you have kept us in touch with what was going on in the power field.
>
> I hope you do not think you should make up back numbers or extend subscriptions. We all appreciate what you have been up against and the way you have handled it.

> Received my Oct. 7 issue today and have been giving it the once over. It is like getting home after a long absence—mighty good to be *back.*

> I will just write a few lines to let you know that I am well pleased with the stand you are taking during the strike in not attempting to publish *Power.* I am afraid that I would have to discontinue my subscription if you should try to publish *Power* with strike breakers.

> As a subscriber to *Power* I wish to thank you for the trouble you have been to, to keep us posted on things in the engineering world.
>
> I sincerely hope that the time is close at hand when your troubles will be adjusted and conditions will be normal, for your benefit as well as my own.
>
> While I am a firm believer in organized labor, it seems to me, to use an expression common among the natives here, that labor has "gone hog wild."
>
> But I hope the pendulum has about reached the end of its stroke and will soon start on its return.
>
> In the meantime we will mark time and wait for the return of *Power.*
>
> I have been a subscriber to *Power* for over fourteen years and have never missed a copy until the strike and it is like losing an old friend to be without it. I intend to remain a subscriber to *Power,* strike or no strike, for to again quote the natives, "I am with you from hell to breakfast."

> I wish to express myself in some manner which will give you assurance that myself as well as many others who are subscribers to *Power* are perfectly willing to sit tight in the boat and wait until conditions readjust themselves. In other words, we are with you and will continue to take *Power* whenever you can issue copies of the same.

These are representative of a large number, a convincing and grateful demonstration of the cordial and sympathetic relations that exist between *Power* and its readers.

Fill Up the Coal Hod

THE industries of the country, the transportation of the nation, the domestic life of the community are threatened by the shortage of coal.

The miners claim that they cannot live on the pay that they are getting and called a strike. The rate per ton or per day, is not so bad if the employment were steady, but the miners must stay around and report for duty all the time for the sake of a chance to work part of the time. They therefore demand a sixty per cent. increase in wages and a six-hour day, claiming they can mine in that time all the coal they are mining now and that the increased wage rate is needed to meet the increased cost of living.

Secretary of Labor Wilson says they ought to have an increase in wages of thirty-one per cent. Fuel Administrator Garfield says an increase of fourteen per cent. will put them on a parity with other trades.

Ex-Secretary of the Treasury McAdoo says that according to their income tax and excess-profit returns the operators have been making from one hundred to a thousand per cent. of their capital stock, and that they can afford to meet a considerable increase in wages without raising the price of coal to the consumer.

The President declared it unlawful for a body of men to conspire to restrict the production or distribution of so vital a necessity as coal, and the Government enjoined the strike, which was called off by the leaders. Whereupon there was a great outcry about "involuntary servitude" and the inviolability of Labor's right to strike. Ex-President Taft points out that if the purpose is lawful and the method is lawful, the right to strike must and will be preserved and respected by the courts, but if the strike is for an unlawful purpose, it is no more under the protection of the Constitution than any other unlawful injury or crime.

Nothing but unsupportable conditions, to relief from which all other avenues were closed, would justify a body of men in holding up the fuel supply of the nation on the verge of winter. If there was ever such justification for the strike of the miners, it is over now. Their case is before the representatives of the people if not before the people themselves. They can secure no more thorough or favorable consideration of it by impeding the railroads, stifling industry and causing no end of discomfort and expense in public institutions and private homes. To continue to do so will be the best possible way of alienating that public sympathy which they need if their case is to be won.

Let them get busy and fill up the coal hod while the discussion goes on.

Let the public into the discussion and give it the benefit of the facts.

The people are the ones who pay the wages of the miner and the profits of the operator and middleman. They have a right to know what they are paying for.

They want the miner to have money enough to live and bring up his family in accordance with the American standard, and save enough to support himself when his productive period is over. But they don't want to be held up for an extravagant raise by a threat of having their fuel supply cut off in the dead of winter; and in the absence of any explanation, sixty per cent and a six-hour day looks like a hold-up.

They want the operator to get a fair profit, not on a paper valuation, but upon the cost of operation, including a fair interest on the capital actually invested.

The situation has all the possibilities of serious trouble. We hope it will be settled before this issues from the press. But whether it is or not, let us have the facts. Put the cards on the table, face up. How much did the average miner make year in and year out at the prices prevailing before the strike? How many hours a year did he work and how many hours did he have to stand around ready to work? How much have the operators been making? How much of the proposed increase in wages do they purpose taking back from the miners by increasing the cost of his necessary supplies?

Information of this sort rather than execrations of the capital and wage system or florid denunciation of radicalism is what the public needs in order to make up its mind as to the merits of the case, and as the public makes up its mind so is the thing likely to be settled in the long run.

And there is one thing that the public has already made up its mind to, and that is that it wants its coal; and any act of operator or miner which interferes with the prompt resumption of its mining and distribution at a normal price will prejudice his case in the eyes of this court of final appeal.

Measurement Of Maximum Demand

When an industrial concern contracts for electric power or when the user of electricity receives the monthly bill, it will often be found that the charge is based on two rates—the total number of kilowatt-hours used and the "maximum demand." This additional charge is often mystifying and hard to justify without knowing the reason for its existence. Electricity is not like water or gas, which may be pumped or generated at a uniform rate over a period of twenty-four hours and conveniently stored until the customer wishes to use it, when he may use a large quantity in a short period without making it necessary to increase the size of the twenty-four hour pump or gas generator. In such a case there is no reason why a customer should pay more because he uses a larger quantity in a short time, as the equipment need not be any larger.

But electricity cannot be stored commercially; it must be generated only as used. Consequently, the size of the generators and other equipment must be large enough to supply a twenty-four hour load equal to the customer's greatest power demand, even though he uses the power only for a short period per day. This is why a large power bill is seldom charged according to the kilowatt-hours only. The cost of equipment depends also on the rate of consumption; consequently, the additional charge of so much per kilowatt of maximum demand.

On another page of this issue is an article "Measurement of Maximum Demand," giving an example of how the maximum-demand charge affects the monthly bill. This is followed by simple directions for determining the maximum demand with the ordinary watt-hour meter and a list of the various principles of operation employed in maximum-demand meters, which should assist in clearing up this feature for those not familiar with a maximum-demand charge.

Industrial concerns with a maximum-demand clause in their power contracts may find that by a proper division and supervision of their loads it is possible to effect a large saving in the electric bill, simply by extending the load over as long a period as possible and avoiding the use of an excessive maximum demand. For instance, if the motors driving the plant machinery are shut down at the noon hour, this period may be used to pump a tank of water in preference to pumping when the other motors are running. Or if several large grinders are used, the work can be arranged so that one is being refilled while the other is in operation. Or if the plant must be operated evenings with all the lights burning from the power circuit, some unimportant machine can be shut down. Numerous cases will present themselves to the alert engineer which may result in a considerable reduction in the power bill when using the same amount of power, but simply keeping the maximum demand as low as possible consistent with the total power consumed.

Is the Owner About to Understand His Engineer's Problems?

"Why didn't you say that in the first place?" How often one hears that question exclaimed. There cannot be appreciation of another's point of view when there is lack of understanding or when there is misunderstanding about them and their related circumstances. This is the chief reason that power plant owners and industrial plant managers so little appreciate the problems of their power plant engineers, and, therefore, co-operate not at all or inadequately.

Several attempts have been made to bring engineers and managers together to the end that each might better know the other, not in a fraternal way but in a business sense. No attempt seems so capable of bringing real, lasting results as that made by the Educational Committee of the Manufacturers' Association of Knoxville, Tenn. Through the association's efforts the University of Tennessee is now conducting power plant courses financed by the engineers. The courses extend over twelve weeks and there will be two terms. The complete course with books costs each student ten dollars.

The plan differs from that of the University of Wisconsin, but both are alike in purpose. It is too soon to tell what those in Tennessee will accomplish, but the greatest obstacle was overcome when the owners and managers agreed to meet with the engineers. They will have a banquet this winter conducted by the engineers.

The Phillipsburg, N. J., Association of the National Association of Stationary Engineers is another body which has accomplished things worth while in this direction. The manufacturers are with them to such extent that they attend association meetings and see to it that every assistance and opportunity is given the engineers to promote their work. The manufacturers of Elizabeth, N. J., are now interested and the coming season likely will see closer co-operation between them and their engineers.

Salaries play no rôle in these get-together meetings; it is the betterment of power plant efficiency that is sought.

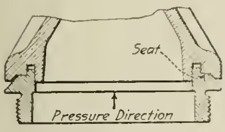
These manufacturers are wise indeed. The engineers are anti-radicals by tradition. They are too keenly aware of their vital importance to public welfare, too appreciative of their far-reaching responsibilities to betray their trust and themselves. They are too American to think that they must cripple all industry to get a hearing, not about wages, but about bettering the efficiency of that basic thing upon which all modern industry depends—power generation.

It is truly up to the plant owners and managers to take advantage of such excellent esprit de corps.

CORRESPONDENCE

Water-Column Blowoff Value

I have read various communications printed in your magazine concerning valves for water-columm blowoff service, one being in the issue of July 1, page 27, and another in the issue of Sept. 23, page 518. We believe that there is something in all these arguments, but it seems that none of the writers has yet given a solution of the difficulty.



DESIGN OF DISK AND SEAT

Water-column blowoff service is similar to boiler blowoff service in that it is a valve that is subject to extreme temperature changes and the passage of a certain amount of grit and dirt over the holding faces. There have been all kinds of development of a suitable valve for boiler blowoff service, and I believe that the only reason there has not been the same development for water-column blowoff service is because of the ease with which these small valves may be taken out and replaced; nevertheless, this replacement is a continual nuisance and in proportion as much an expense as the upkeep of blowoff valves.

A blowoff valve with a protected seat and disk, as illustrated, would solve the problem and, if used, water-column blowoff difficulties will be vastly decreased.

It is particularly suited to take care of the differential expansion between the internal and external parts of the valve. The body has a coefficient of expansion of 0.0000154, while the internal monel parts have a coefficient of 0.0000076. Therefore, when this valve cools, the disk is really pressed tighter to the seat than when closed off while hot, thus insuring against this seat lifting when cooling down.

Pittsburgh, Penn. B. M. Herr.

The Education Of An Engineer

In the course of my experience as an engineer I have worked side by side with, and have been in a position to become intimately acquainted with, a great many engineers of different types and various degrees of ability. When you work side by side with another man, or in the same plant, you have an excellent opportunity to discover just about how much he knows. If you are a keen observer, you will soon be able to ascertain whether the other man is good, fair or poor in his ability as an engineer.

It is interesting to observe that the average engineer will cram his brain full of technicalities in preparation for his engineer's examination, because he could hardly get a license without it. After he has secured his license he is done with the dry, uninteresting textbook. He has had enough of that. This is just where he makes a mistake. A good textbook is an invaluable thing. An engineer should freshen his memory continually, strive not to forget the things that he has learned and endeavor to keep up with the advancement of the engineering art, as there are new ideas being developed every day.

In the columns of the trade journals he can read of the experiences and problems that were confronted by his fellow-craftsman, and he will find the solution to many a kinky problem and a great deal of the technical knowledge that the average engineer requires there, and I have noticed that the engineers who fail to read the popular journals are few and far between.

Los Angeles, Calif. Roland L. Tullis.

Different Water Levels In Heating Boilers

On page 519 of the Sept. 23 issue of *Power*, in response to an inquiry as to the cause of the variation in water level in two cast-iron sectional heating boilers connected together, you state that the trouble undoubtedly arises from the difference in the loss of pressure in the return water. You further state that with the ordinary sizes of steam connections the steam pressure in the boilers would be substantially the same even for considerable difference in rates of evaporation, and although this trouble is commonly attributed to the difference in steam pressure, trouble from that cause is rare.

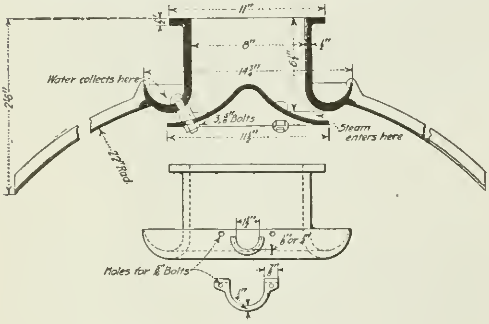
My experience leads me to believe that the trouble is usually due to steam connections that are too small and that if connections of the size generally used are installed there is likely to be trouble from this cause. On the other hand, with returns of the sizes that are customary in steam-heating practice, the friction of water flowing through a wet return is almost negligible. When two boilers are connected to one set of mains and are fired alternately, one boiler will at times be worked at a much higher rate of evaporation than the other and, in fact, under an active fire do much more work than it was designed to do. Under this condition there will be an extensive drop in pressure between the steam space in the boiler and the main; so extensive, in fact, if the steam connections are not unusually large, as to cause the water to disappear from the glass. This can be corrected either by making the branch steam pipes and the main larger or by adding an equalizing pipe of proper size between the two boilers. It is a practice of the office with which I am connected to be very liberal in the matter of steam connections when two or more boilers are to be connected to one main and to make no difference in the size of the return connections.

New York City. Henry C. Meyer, Jr.

Why Does the Water in a Boiler Lift When the Safety-Valve Blows?

The editorial in *Power* of the June 24 issue, "Why Does the Water in a Boiler Lift When the Safety Valve Blows?" interested me considerably. I was not aware that there was any great amount of trouble from water being lifted when the safety valve opened, but even if the valve does lift quickly and high, I have never had any trouble from this cause. I have, however, had experience with water being carried over in the main steam pipe, both as wet steam and as entrained water.

Having been a boiler inspector for twenty years, I have paid considerable attention to the quality of steam delivered. In inspecting boilers I have paid particular attention to the kind of dry pipe or separator used and the height of the water line near the steam outlet. I have always found the water line higher on the shell (either in horizontal-tubular or water-tube boilers), right opposite the steam outlet on both sides and streaks on the shell, indicating that the water crept up the shell to the steam outlet, and that the longer the dry pipe the wetter the steam, caused by the extra length of pipe acting as a collector of water instead of as an eliminator. As the round separator is fastened to the steam pipe inside of the boiler and taking the steam from the top near the shell, it, at times, furnished very wet steam. Boilers with such devices cannot be driven very hard without sending over considerable water and there is almost always considerable mud in the opening of such separators. This all indicates that it was carried there by the water.



SEPARATOR FOR STEAM BOILERS

If there is trouble from water lifting when the safety valve blows, I am sure the most of the water comes up around the shell to the safety valve, if the water is 18 in. or more away from the opening. Even an angle fastened to the shell, two or three feet long on each side above the water line, has been known to help considerably in keeping the water from being carried over to the engine.

Acting on this information I patented an inside separator that collected any water that may be carried up on the shell, and that which is constantly dripping down from the shell, and conducted the water back to the water line in the boiler in such a way that it cannot be swept up by the outgoing steam. The device was so shaped as to get the largest quantity of steam out through a given opening and causes the least disturbance of the water, by shaping it so as to prevent, as far as possible, any whirling motion to the steam which would cause it to act on the water in the boiler and cause a water spout. This might be what happens when the safety valve rises quickly and high as mentioned in the editorial. This separator, see illustration, has been very successful and by making the opening the proper size I can deliver steam with less than one-half of one per cent. of moisture.

A conical baffle plate on the bottom of the separator prevents the water from rising from the surface and regulates the size of the outlet. In providing a device to keep the water from being lifted by the safety valves it would be better to leave the baffle plate off, if possible, as then there would be no restriction to the outgoing steam. It appears to me that if the water which creeps up the side of the boiler is prevented from going out the steam would not be wet enough to cause trouble. I am sure that I can make the device so that the safety valve will not draw up the water, and at the same time be reliable and allow the safety valves to take the required amount of steam.

In a certain office building there are three water-tube boilers. The engineer and the superintendent of the building complained to the maker of the boilers that they were furnishing wet steam. The boilers' maker, knowing of my separator, asked me to see what I could do. I put a separator on each boiler, first trying out one boiler and then running this one boiler with forced draft with the water almost up to the top of the water glass, the moisture in the steam was less than one-half of one per cent. In making the calorimeter tests I found that the steam was drier when the water was high in the water glass than when it was low, and that when it was real low it had a tendency to get wet, just the opposite to the general belief.

After a little consideration I discovered the cause of this. The steam outlet on these boilers is on the front of the drum, directly over the front header where the water circulates up into the drum. When the water was high this rapid circulation, with the force of the draft on, could not spout up through the water and mix with the outgoing steam; but when the water was low the water shot out of the header in geyser-like action and mixed with the steam. There was no trouble to get dry steam with two or three inches of water in the water glass. Such might have been the case with the safety valves in question. J. F. FENNELL.

Philadelphia, Penn.

Nearly all engineers think that a high velocity tends to lift the water in a boiler. If this is so, then the smaller the valve handling a given amount of steam the greater will be the velocity and more water will be carried over. For instance, a 3-in. valve, having a capacity of 8650 lb. of steam per hour at 125 lb. pressure, would have a tendency to lift more water than would a 4-in. valve under the same conditions. I think that the subject is a very important one and should be given all the attention possible.

I was recently called on to design the piping in a large power plant, and the question of pipe size from the boiler to the header was important. The boiler was supposed to have a generating capacity of 6000 lb. steam per hour, at 150 lb. pressure. The boiler nozzle was 9 in. and the engineer in charge insisted that I make the pipe 9 in. from the boiler to the header. This would have produced a velocity of approximately 600 ft. per min. and a drop of only 0.015 lb. per hundred feet. This low velocity would cause considerable condensation and would be too low to properly operate the nonreturn valve. I insisted that the pipe should be reduced to 5 in. which would create a velocity of 1980 per min. and a corresponding drop of 0.275 lb. per hundred feet. This velocity and drop I believe are considered very low and should be at least 4000 ft. per min. and approximately 1 lb. per 100 ft. respectively. This would require a 3-in. pipe.

This engineer is now complaining that owing to the pipe being reduced to 5 in., the boilers are priming, and he has requested that we make the pipe 9 in. I contend that these boilers are priming because they are very much overloaded and that a 9-in. pipe will only make it worse. I would like to have some expert opinions on the subject. Does high velocity through pipe or valve on boilers tend to lift the water? There is a statement made by one of our best writers that the "drop of pressure of steam does not cause a loss of energy." If this is so, and a high velocity does not tend to lift water, then why not increase the velocity and use smaller pipes?

Memphis, Tenn. H. T. Fryant.

What lifts the water from the level of the water line and throws it out of the safety valve? This action of the water is inevitable in all safety valves and the same action is implied in the steam leaving the boiler through the steam pipe leading to the engine, with the added damage resulting therefrom.

I have found that the wreckage of hoisting engines is caused almost exclusively by the water being drawn in slugs into the steam pipe and then into the engine, where according to natural law no two bodies can occupy the same space at the same time, it compels such quick action that something must give way.

The wreckage occurs by the piston striking the water in the cylinders so suddenly as to tend to stop it, and the momentum of the heavy winding drum does the rest. Any one of a dozen parts may break; the crank, the crosshead or the piston itself. The crankpin may be loosened, or the strap bolts of the connecting-rod may be sheared, the cylinder head smashed, or as an alternative the water may escape by lifting the valve and passing into the exhaust. But water is solid and would have to back up the side pipe instantaneously or a little quicker, to relieve the pressure. Pillow block caps and bolts are broken by the shaft, including perhaps a 15-ton drum being jumped up to let the crank pass over, or the bedplate may be broken.

Away back in steamboat times this experience was thrashed out and decent results obtained, after innumerable smash-ups, by using large steam drums, and large outlet pipes or legs connecting the boiler and the drum and by making the end of the steam pipe project into the drum near the center to avoid the slugs of the water from the boiler. All of this experience is now ignored or forgotten. C. W. Crawford.

Brazil, Ind.

I am much interested in the subject of safety valves, their size, lift, sudden release, etc., which was brought up in a recent editorial in *Power*. It seems to me that A. S. M. E. acted wisely in removing the limit on the amount of lift of safety valves, but I cannot say the same in regard to the removal of the limit on the size.

In my opinion the gradual opening of the valve has no bearing upon the amount of priming caused by the blowing of the valve, provided, however, that the water level is not so extremely high at the time that any sudden release of pressure may cause a rupture to occur.

Getting back to the question of size, it is my belief that the removal of the limit on the size is a step backward and that instead of taking this step we ought to go in the opposite direction and make safety valves smaller. Take, for instance, a boiler running, say, at 200 per cent. of rating; the allowable pressure is exceeded and a safety valve large enough to discharge all the steam the boiler is capable of generating "pops," adding another 250 per cent. or more of rating to the load on the boiler. Under these conditions what else can the boiler do but prime? And it does prime, not only through the safety valve, but also into the steam main.

If, however, this same boiler had been provided with several smaller valves set to blow a few pounds apart, then when the pressure exceeded the limit the first of the valves would open and add, say, 40 or 50 per cent. of rating to the boiler and probably little if any priming would take place; and if for some reason the entire load was taken off the boiler while driving at a high rate, all the valves or as many as was necessary, would go into action as their respective pressures were reached.

This, I believe, is the only sensible method to secure safe and gradual release of pressure in any boiler.

East Chicago, Ill. Charles L. Anderson.

Breaking of Wedge-Bolts

I have read of several instances where the breaking of wedge-bolts has caused trouble, and it may interest engineers who have gone through this hair-raising experience on their first introduction to that gentle knock at both ends of the stroke when the throttle is almost tight.

The first time I heard this knock I did not know whether to get outside the plant or stay inside. Anyhow I stuck, and after looking things over I found that the only damage done was to the adjusting wedge-bolt on the crank, the head being broken off short. A day or two later another one broke, then another, and still another. I began to see all kinds of things happening. My imagination of what might happen ran into a nightmare. But I started in to overcome it. I shaped the heads on the bolts so as to eliminate a sharp corner, making them of tool steel and annealing them; but they broke just the same.

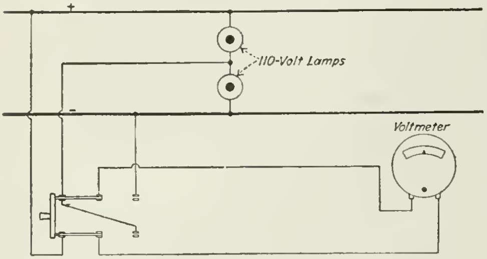
Finally, I recollected that Norway iron is about the toughest thing known in the metal line. So I got a bar of the right diameter, cut it into lengths about four inches longer than the bolts and had the blacksmith upset one end large enough to shape up a head. Then the machinist made up the bolts to fit. This ended the trouble. B. Gaddis.

New Rochelle, N. Y.

In a recent case (Norfolk & Western Co. vs. Royal Indemnity Co., 257 Federal Reporter, 849) the United States Court for the Eastern District of Pennsylvania decided that a policy of insurance of a boiler against explosion or rupture did not extend to rupture of a whistle pipe above the whistle valve.

Extending Range of Voltmeter

It sometimes is necessary to measure the voltage of a circuit when there is no voltmeter available having a high enough range. The accompanying diagram shows how a voltmeter having a scale range of less than 220 may be used on a 220-volt circuit, by measuring the drop across two 110-volt lamps connected across the line; then, by adding the readings, the exact voltage of the circuit is obtained.



CONNECTIONS FOR EXTENDING RANGE OF VOLTMETER

The double-throw switch, while not absolutely necessary, renders it easy to take the two readings simultaneously. If the voltage is fluctuating, more accurate results can be obtained by several sets of readings and taking the average of them.

This method can be used for measuring the voltage of any circuit; as, for example, by using 220-volt lamps and a voltmeter having a scale of less than 440 for use on 440-volt circuit. Or if unable to obtain a voltmeter reading of half value, more than two lamps can be used in series and the voltage taken across each lamp.

Readville, Mass. HOWARD M. NICHOLS.

Difference in Heating Systems

Replying to L. B. Shields as to difference in heating systems, page 867, June 3 issue, it is poor practice to inject cold water into vacuum return-mains. If the pump and pipe sizes are correct and the pipe lines are tight and the radiator traps pass no steam, there should be no difficulty in maintaining the necessary vacuum. If cold injection was used as feed water, there would perhaps be no heat units lost, but if it was pumped to a receiver with overflow the lost hot water would mean wasted coal.

I presume the increase in vacuum near the pump was due to leaks from radiator traps being condensed by the cold-water jet. Perhaps the pump could be put in a pit to advantage with a higher vacuum (if there is enough radiator surface), and perhaps it would be possible to get along with exhaust steam only.

New Britain, Conn. WILLIAM DOWNHAM.

Judging from the illustration shown in Mr. Shield's letter, the heating system that he describes is surely a troublesome and wasteful one and I doubt if there was 4 in. of vacuum at the radiators or 8 in. at the pump for half the time. The reason for connecting the returns 8 ft. below the suction line of the pump is not given, but a pump will not satisfactorily lift hot water, as the vapor destroys the vacuum.

In the instance of a thermostatic-controlled system the diaphragm valve at each radiator shuts off the steam and if there is a check valve between the radiators a vacuum is created if there is no automatic air vent. When the diaphragm valve opens again, the steam rushes in to the radiator, destroying the vacuum and causing the system to knock and pound on account of unequal temperatures. If the return from each radiator is connected independently to the main below the pump, then when the diaphragm valve opens the steam rushes through the radiator to the pump, causing more knocking and pounding of the pipes.

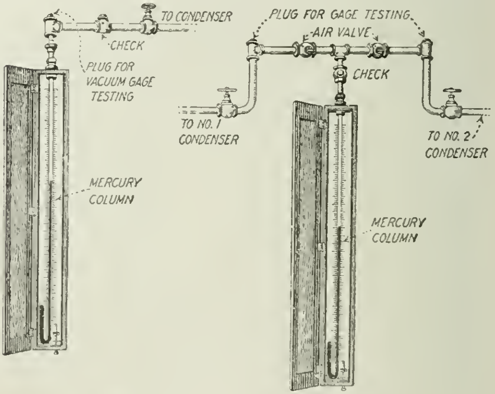
The best way in such a system would be to connect the returns to steam traps in the basement and discharge the traps into a receiving tank placed 6 in. above the suction line of the boiler-feed pump. The cold-water supply should be connected to the tank and its discharge controlled by a ball-cock. If it is a closed tank, connect a vapor pipe from the top of the tank to the roof. The pump should be controlled by a governor, of which there are many types. PATRICK MOLLOY.

New York City.

Check Valve in Mercury-Column Connection

Having seen various kinks published in *Power* and having been greatly benefited by them, I offer the following:

After having had trouble with mercury blowing out of the mercury column when starting up, we tried putting swing check valves horizontally in the mercury columns. They operate successfully and help to keep the mercury clean and to prevent water from collecting in the mercury receptacle.



PIPING TO SINGLE- AND DOUBLE-FLOW MERCURY COLUMNS

On the double-flow type of mercury column I have air valves which are used instead of globe valves for appearance only. On double-flow column we use one mercury column instead of one for each condenser, and by closing either one air valve or the other we can get the reading of either condenser. HENRY C. SHATZ.

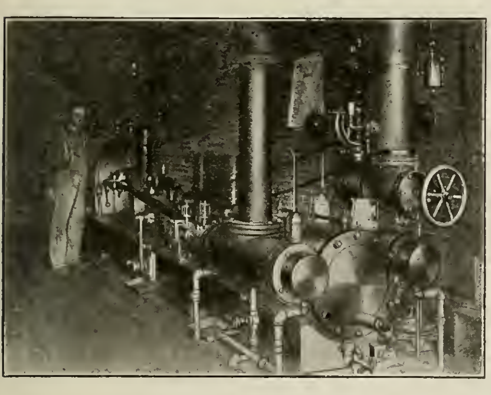
Sinking Springs, Penn.

Oil can be separated from exhaust steam by passing the steam through an oil separator. A separator should not be specified by the size of the engine exhaust pipe, but rather by the quantity in pounds of steam per hour to be freed of oil.

Peculiar Engine Design

At the mills of the White River Lumber Co., Mason, Wis., may be found one of two engines of peculiar design, the only two that are known to be in operation; the other one is at a Washburn, Wis., grain elevator.

The main peculiarity of the engine, which is one of the box-bed type, is that separate piston valves are used for the steam and exhaust control. The valves are actuated by an eccentric which controls the steam valves, shown at the right in the illustration, and by means of a rocker-shaft and rocker-arm also actuates the exhaust-valve shown at the left.



AN ENGINE OF PECULIAR DESIGN

Upon examining the illustration one wonders why the exhaust connection was not made from the bottom of the valve chamber rather than the top. This engine was installed in 1894 and was second-hand. It has a cylinder 20 x 20 in., and the piston valves are of the inside type. The engine was operated without a governor for several years after it was installed. Later the governor shown was put on. A detachable hook-rod is used so that the engine can be started and stopped by hand.

The main-bearing quarter-boxes are adjustable from both front and back, and the crankpin is put in the crank with a taper and secured in place with a nut.

For some reason both the steam and exhaust barrel chambers are tapped for indicator connections, the connections being shown in the exhaust chamber in the illustration. The cylinder has relief valves on both ends. It is not known who were the original builders of the engine. L. J. Mann.

Virginia, Minn.

About Licensing Boilermakers

I would like to say a few words regarding compelling boilermakers to pass an examination and secure licenses before they can repair boilers. I agree with C. S. Regan in a recent issue that a better plan would be to allow no repairs to be made until after an examination by a qualified state, municipal or insurance inspector.

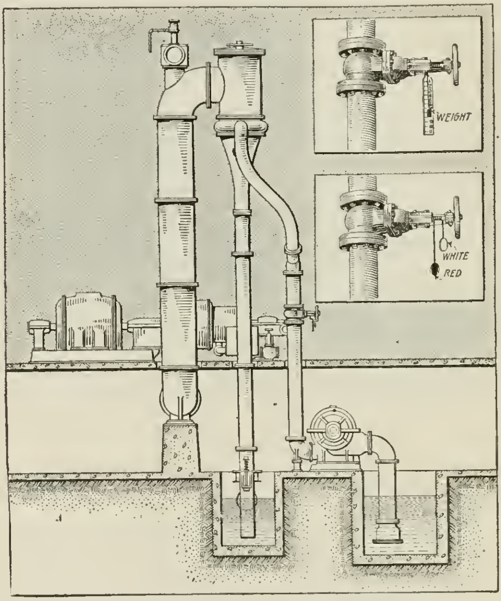
In my experience I have noticed that some of the most expert boilermakers were men who could hardly write their own name. They had no technical education, but had started in as apprentice boys and learned every step of their trade from hard practical experience in the boiler shop. According to my idea one of these mechanics is worth about a dozen of the technical-school men having but little experience.

New York City. S. J. Francis.

Indicator on Injection-Water Valve

A valve was inserted in the injection line of a jet condenser that was used with a turbo-generator. This valve was seldom wide open, but was varied to suit the load, otherwise the condenser would be flooded. The engineers knew by experience the number of turns to take on the valve wheel when starting up and also for the various loads. But this necessitated counting the number of turns, and in the hurry of starting, etc., this method was not always the best. The following idea was adopted to show at all times the amount of valve opening, and it can readily be used in other instances.

The large illustration and top insert show the idea, which consists simply of a cord, one end of which is attached to a weight, the other end being secured to the valve stem by means of a pin. A card, graduated by trial, is affixed alongside of the weight, and the position of this weight corresponding to the valve opening will at all times be indicated.



INDICATORS FOR VALVE STEMS

A modification of this scheme, to serve as a warning sign as to whether or not the valve is opened, is illustrated in the lower insert. In this case a red disk is attached to the weight and its position hanging below the valve wheel will indicate danger. Another weight, with a white disk, is attached to a cord and secured to the stem so that it will be wound up while the red disk is down and vice versa. This will indicate valve open or valve closed. The disks can be changed to indicate in the opposite manner, if preferred.

Richmond, Va. James M. Purcell.

Value of Temperature Charts

The accompanying temperature charts may be of interest to readers of *Power* as they are an added proof of the value of recording instruments in determining the conditions which exist at any given point and sometimes are the "evidence in the case" which is necessary to clinch the argument for added instruments, as the following case will show.

The charts shown herewith are reproduction of charts taken under actual running conditions and record the temperature of the feed water entering a battery of boilers of several hundred horsepower.

The source of the feed water is the hot return water from several mills which use the exhaust from the engines for process work, the condensate being returned to an open tank consisting of a cylindrical drum vented to the atmosphere through a 6-in. pipe.

Each mill has its own return tank, the condensate being pumped from the mills to a common return tank located in the boiler house which supplies the mills with steam.

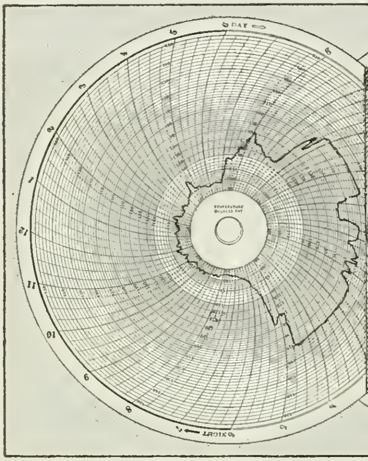


FIG. 1. AVERAGE TEMPERATURE OF 140 DEGREES

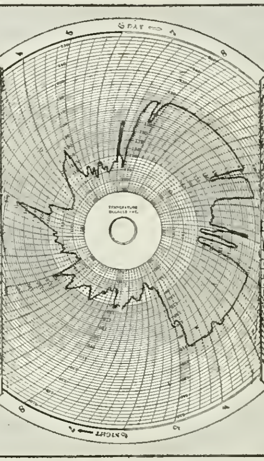


FIG. 2. TEMPERATURE AVERAGE 165 DEGREES

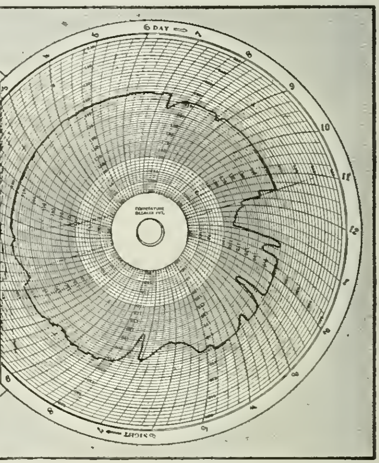


FIG. 3. AVERAGE TEMPERATURE OF 208 DEGREES

As each return tank was equipped with a water line for introducing cold water and as the amount of water pumped to the boiler plant was under hand control, the boiler house frequently suffered from too much return water at a correspondingly low temperature, the excess passing out at the overflow with a consequent waste of good fuel which cost real money.

The first step in remedying the condition was placing a recording thermometer on the feed line to acertain the temperature of the feed water, and it was discovered that the temperature was much cooler than was generally supposed.

After a short time means were taken to find the cause of the low temperatures, and chart No. 1 was taken as a sample from which to start operations and the following points were noted: The drops in temperature at 11.45 a. m. and 4.45 p.m. were due to shutting down a small coal conveyor engine, but the drop at 5.15 p.m. with a rise at 7.00 a.m. led the writer to investigate running conditions at one of two mills which discharged their condensate to the boiler house through the same line and it was discovered that one mill shut down at 5.00 p.m. while the other one ran the full 24 hours. It was also discovered that the former mill returned its condensate by means of a centrifugal pump, which had no check valve on its discharge pipe, and in shutting down on the day on which the chart was taken the operators had neglected to close the stop valve, with the result that the condensate from the mill which was running had backed out through this centrifugal pump into the sewer instead of going to the boiler house.

A check valve placed in the discharge from the centrifugal pump produced chart No. 2 with a rise of 25 deg. in the average temperature of the feed water, which showed a good saving in coal.

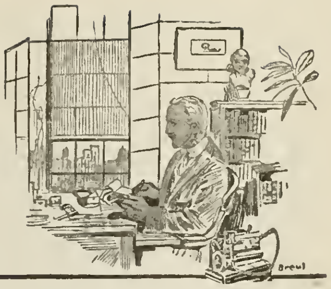
I felt that this chart could be made considerably better if the cold-water valves on the mill tanks could be watched more closely, and by watching the chart and adjusting the cold-water valves chart No. 3 was produced, which shows an average of 208 deg. for the 24 hours, and this was considered to be as good as could be expected with hand control. Having attained this mark and knowing that it is possible to secure this result, the next thought was to devise a method whereby we could maintain the desired temperature automatically, and the solution seemed to lie in something along the line of a thermostat, but it was desired to get the benefit of a 210-deg. feed while the thermostat control was being developed.

With the evidence thus far secured it was an easy matter to secure the purchase of four recording thermometers, one of which was placed on each mill return tank for the guidance of the operating engineer in regulating the cold-water valve, and the investment has proved a wise one. Our feed temperature now averages between 200 and 210 deg. every day, and a method of automatic control has recently been placed in operation which we believe will maintain a uniform feed temperature.

C. B. HUDSON.

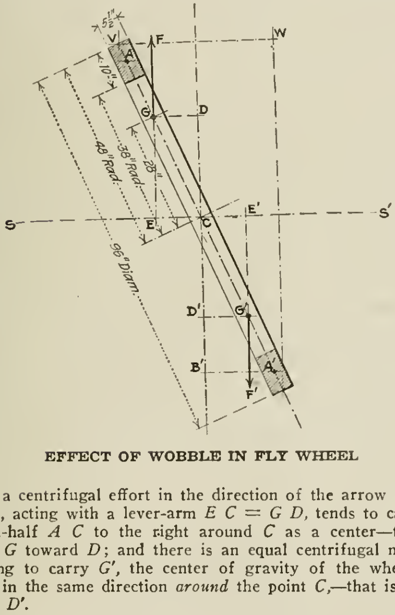
Holyoke, Mass.

INQUIRIES OF GENERAL INTEREST



Shaft Bending Effect of Wobble in Flywheel—The overhung flywheels of an air compressor are 8 ft. in diameter, and one of them has a wobble of ¼ in. The rim is 10 in. deep radially by 5½ in. width of face. Neglecting the weight of the hub or arms, what is the bending effect on the shaft with a speed of 100 r. p. m.? S. B.

Referring to the diagram, assume *S S′* to be the center line through the shaft, *V W* the amount of wobble and *A C S*= *A′ C S′* the angle of inclination of the central plane of the flywheel rim to the center line of the shaft. Then the center of gravity *G* of the half rim *A C* will rotate in a plane that is a distance *G D* from the plane of rotation *C D* in which *G* would revolve if the wheel ran true. The weight of the half *A C* may be supposed to be concentrated at *G*. Rotation produces a centrifugal effort in the direction of the arrow *E G F*, which, acting with a lever-arm *E C* = *G D*, tends to cast the wheel-half *A C* to the right around *C* as a center—that is, from *G* toward *D*; and there is an equal centrifugal moment tending to carry *G′*, the center of gravity of the wheel-half *A′ C* in the same direction *around* the point *C*,—that is, from *G′* to *D′*.



EFFECT OF WOBBLE IN FLY WHEEL

For the given diameter and radial thickness of rim, *C G*, which is the radius of the center of gravity of the rim, would be about 28 in., and as the wobble of each half-rim would be ⅛ in. = 0.125 in., then for 28-in. radius we would have *G D* or $E\,C = \frac{48}{0.0125} \times 28 = 0.0729$ in., or 0.006075 ft.

Taking the weight of cast iron as 0.26 lb. per cu. in., one half-rim would weigh $\frac{2}{3.1416}$ [(48 x 48) — (38 x 38)] 5½ x 0.26 = 1931.7 lb.

The radial distance *G E*, or distance of the center of gravity of the half-rim from the shaft axis of rotation, would be $\sqrt{G\,C^2 - E\,C^2} = \sqrt{(28)^2 - (0.0739)^2}$, or practically 28 in. = 2.33 ft., and the centrifugal effort in the direction *G F* computed by the formula, *Centrifugal force* = 0.0003408 $W\,R\,N^2$, assuming, W = 1931.7 lb., R = 2.33 ft., and N = 100 r. p. m., would be 0.0003408 x 1931.7 lb × 2.33 ft. × $(100)^2$ = 15,338.9 lb., and that force, acting with a lever arm *E C* = 0.006075 ft., would exert a bending moment around *C*, which would be equal to 15,338.9 x 0.006075 = 93.183 lb.-ft. from one of the halves or 186.366 lb.-ft. from both halves of the wheel when up to speed, always acting on the same part of the shaft, with a tendency to increase the angle *G C S* to 90 degrees.

Engine Piston Leakage—Will a piston leak steam when traveling even though it may seem to be right when blocked and tried; and could there be such a thing as leakage past the rings when changing the direction of travel at the ends of the stroke due to side play of the rings? H. L. K.

It is practically impossible to prevent all piston leakage The wear of the cylinder is not uniform for the full length of the stroke, and testing the tightness of the piston at one point does not demonstrate its tightness at other points along the stroke. Leakage may be introduced by side slippage of the rings from reversal of the stroke, but this, like leakage shown by blocking the piston at any point, may be only momentary, while the piston is traveling over that particular point, and it should not be taken for granted that the degree of tightness or rate of leakage found with the piston blocked is the rate of leakage during regular operation. The leakage when running will be considerably less than the highest rate of leakage observed with the piston blocked at a point that shows the most leakage.

Amount to Set Up Bearings—How much should the main bearings of a gas engine be set up to allow for lubrication and quiet running? J. O. B.

The amount cannot be generally stated, as in any case it depends on the alignment, material, workmanship, condition of the journal and bearing, viscosity and wearing properties of the lubricating oil, uniformity of supply and distribution of the lubricant, the surface speed and pressure and kind and amount of dirt likely to find its way between the bearing surfaces. Gage the approximate thickness of shims required when the caps are set down hard on the journals with pieces of soft lead wire compressed between the shim surfaces Try out the setting of the caps with ample thickness of shims and gradually reduce the thickness until the bearings show a tendency to cut or heat.

Cylindrical Tank Capacity in 200-Gal. Intervals—What is the formula for laying off a measuring rod to determine for 200-gal. intervals the content of a cylindrical tank 72 in. in diameter by 25 ft. 4 in. long, laid on its side? J. B.

No general formula can be quoted for the purpose. It is necessary to compute the content for various depths and plot the contents against corresponding depths. Then from a curve drawn through points so plotted, determine what depths will correspond to desired intervals of capacity. The operations are described in an article entitled "Volume of Cylindrical Tanks," by W. W. Ward, *Power*, July 30, 1918, pp. 159-60.

Limits of Speed and Capacity of Steam Turbines—Discussion

THE recent New York meeting of the American Institute of Electrical Engineers was devoted to the consideration of the limits of speed and capacity of single-shaft steam turbines and their generators. At the conclusion of the presentation of the three papers, abstracts of which will be found in our issue of Oct. 28-Nov. 4, Calvert Townley, the president, turned the conduct of the meeting over to Philip Torchio, chairman of the Power Station Committee, which had arranged the program. In introducing the discussion, Mr. Torchio said: "It was a little over twenty-four years ago that the New York Edison Company started the operation of the first steam turbine used in a central station in this country at the West Thirty-ninth Street steam station. A week ago the same company put into operation a 35,000-kw. 1500-rev. single-flow machine, which is the largest yet designed for that speed. The machine of twenty-four years ago was a 300 hp., and the present a 50,000 hp.

"This first small unit was a De Laval turbine, built by the French company. After it had been in service for a few years with more or less success, the principal American electrical manufacturers started to build steam turbines. The first American built units were about 500 kw. In 1906 units of 12,000 kw. were built; in 1909 the largest was 14,000; in 1912, 20,000; 1913, 30,000; and in the last year units up to 45,000 kw. 60 cycles 1200 r.p.m. have been built.

"Probably two-thirds or three-quarters of the central station generating equipment today consists of turbo units. When it is considered that the central stations furnish not more than one-sixth of the total power used in the country, aggregating considerably over 100,000,000 hp., and when are further considered such facts as have been brought out by W. S. Murray, that by central-station power generation, of which 93 per cent. is steam and 7 per cent. water, savings in the order of $150,000,000 a year or more can be made on the northeastern seaboard section of this country alone, we are forcibly impressed with the importance of steam-turbine design."

PROPHECIES

B. A. **BEHREND**, consulting engineer, said that in 1906 he had written "The power station of the future will contain as many 20,000-kw. units as the power station of today contains 5000-kw. units." He ventured twelve years later to go on record that the power station of the future will not contain the 75,000 and 100,000-kw. units of which we have heard a great deal in the papers presented this evening.

VIBRATORY STRESSES

Mechanical stresses as encountered in rotating machinery, like the steam turbine, are not static stresses. They are essentially dynamic stresses, vibratory stresses. A disk may be perfectly safe so far as static stress is concerned, and entirely unsafe because of the dynamic stresses.

The ordinary tempered steel used for disks is very hard and he doubted if such steel, in the form of a disk, could be bent flat on itself, without showing rupture. If it does show rupture, it is unsuited for resistance to vibratory stresses and dynamic stresses.

LEARNING FROM FAILURE

Mr. Behrend's experience with accidents in connection with rotating machinery had not been so varied as that of Mr. Berg. He had had only one accident on a machine of approximately 10,000-kw. capacity. He was sorry, because there is nothing so useful as a failure of that sort in bringing one face to face with facts that we are all unwilling to concede. Failures, in his opinion, should never happen twice, because if they do we have not learned from the first failure what we should have learned by careful examination of all conditions that led up to the failure.

The reference to the limitation of capacity being with the turbine only is, he was sure, incorrect. As Mr. Newbury had explained, with 8 per cent. regulation for noninduction load and 20 per cent. regulation for 80-per cent. power factor load, it was impossible to build larger units. You have to double the regulation losses of your generator in order to double the capacity of your unit, the maximum dimensions being virtually the same in the two types of unit, the electrical dimensions having been altered, because the specifications of the electrical dimensions were changed.

STRESSES IN END BELL

The rotating end bells are stressed to such a point that it became necessary to thicken them at the ends so as to make it possible to reduce the stresses to a point where it was possible to obtain commercial materials. In 1902 Sir William Armstrong made up the first sample of steel for these end bells. The stresses ran up to 30,000 lb. under normal conditions, and the ultimate stress must be approximately 100,000 lb., ductility determined by an elongation of 20 per cent., and by a reduction of area of approximately 35 or 40 per cent. These end bells, if thickened too much, will make it impossible to put the rotor onto the shaft, and therefore the limitation lies in the length of the air gap and also the depth of the structure.

It is dishonest on the part of engineers who know their business to assert that these end bells are safe. They have not been in operation long enough for us to come to that definite conclusion. We should wait five years until the fatigue of the metal becomes apparent, and perhaps it will not become apparent in five years, and we must wait ten years, and then fractures may occur. He did not say that this was going to happen. He said that vibratory stresses are dangerous, and that we have not had sufficient experience in regard to vibratory stresses to understand them as we should.

The electrical generator is a machine involving such conditions, a feature which it is impossible to gage at this time, because they have not been in operation long enough to enable us to show that trouble from crystallization and vibration is not going to occur at the stresses we have to choose in order to make these machines workable at all.

It has to be considered, as you go beyond certain favorable sizes, that the cost of the machine as well as the charges which must be met in design increase considerably. Another point of utmost importance is the increase in the armature in these machines, which makes the problem of reducing the heating of the stator coils a difficult one. The heat which is troublesome to the designer is the heat produced in the stator coils, as the result of eddy currents. That trouble increases with the increase in the cross-section of the coils. We face the fact that in increasing the capacity of these machines it may become necessary to increase their voltage in order to obtain smaller conductors in which it is possible to reduce the eddy-current losses to such an extent as to make the machines workable at all.

W. L. R. **EMMETT** said that the less work done in a single operation in the turbine, the more perfect the operation; that is, if you put a small amount of work into a stage of the impulse turbine, you can get rather more perfect nozzle action and rather more perfect performance.

NO REASON FOR VERY LARGE TURBINE

He was inclined to agree with Mr. Behrend that there is no particular reason for building very large turbines. With turbines of the type that the General Electric Co. builds, such as described in Mr. Berg's paper, there is a distinct disadvantage in going to large sizes, involving low speeds, because on account of the great diameter of the wheels there is a waste of space involved and practical difficulties in diaphragm construction, and varying loads on diaphragms, and the physical structure of the stator becomes excessively large and rather objectionable. The large double-unit machine which has been built by the Westinghouse company, in which the low-pressure element operates at a low speed, is a splendid machine, but these machines are quite large and expensive, and there seems to be some question as to whether two entirely independent units, each one complete in itself, may not be about as good a solution of the problem, so far as the user is concerned.

He could see a certain disadvantage in running very high bucket speeds in a machine of the reaction type, on account of concentration of the large amount of work in a single blade, and discrepancies in the areas of successive blades. As he had understood or observed the practice of Mr. Parsons himself, he has not gone in for very high bucket speeds in reaction machines. The construction now used by the Westinghouse company is very fine mechanically, and from that standpoint he should say it was very conservative and good, but what its efficiency limitations might be he did not know. He could not agree with Mr. Behrend's generalization on the subject of vibrating and static strains.

Vibrating Stresses Not So Formidable

If we could not calculate upon or predict the nature of vibrating strains, we could not build anything, because almost everything is subject to motion. However, there are pretty definite laws which govern the question as to whether things do or do not vibrate. One of the essentials of sympathetic vibration is the rather perfect state of elasticity, and many structures that are used in motion are very far from that perfection of elasticity which will enable them to vibrate synchronously with any periodic force. Is the shaft upon which a very inelastic load of material is attached an elastic structure? There are laminations upon it, and these laminations make it relatively inelastic. The end bells, which have been described here, are loaded by masses of coils giving very high weight in proportion to the elastic strain on the ring, and also this mass is in itself inducing a condition particularly favorable to dead runnng, so that he would really, without hesitation, put a strain on such rings to the highest possible degree without any fear of their being broken by vibration.

Distortion of Running Disks Made Visible

Periodic motion is the cause, in Mr. Emmet's opinion, of the breaking of certain wheels in General Electric turbines, and some of the possibilities of that situation were beautifully illustrated the other day in Schenectady. They made up two or three wheels out of rubber, some rather thick with heavy edges, and some thinner with light edges. These edges were loaded with little staples hooked through them so as to impose a load in a manner equivalent to that imposed by turbine buckets on wheels. The wheels were marked out like checkerboards, holes put into them, and they were then revolved on a shaft, a contact point upon which was made to actuate a high-potential spark at one point of its revolution, so that the result, running in the dark, was that the wheel apparently stood still with an exact and perfect definition of its markings. The dry skin on the surface of the rubber was even visible upon close examination, and as the wheel loaded up one could see the skin on the surface of the rubber crack and limber itself out into various forms, indicating the distribution of strains around the holes, and the lines drawn on the wheels would be distorted.

This gave a beautiful illustration of the nature of centrifugal strains in such a wheel. That is what it was done for, and they did not expect to find anything else, but in the case of the lighter wheel, when it ran up to a given speed they began to see something else. The edge of the stationary wheel slowly began to work around like a snake crawling slowly through the grass; that is, it would have three or four points in it that would go worming around, and as the wheel was speeded up the snake would travel faster, but not in proportion to the increase in the speed of the wheel, showing that this state of elastic distention had a tendency to equalize itself through a periodic action. If the disk were shaken, it would vibrate in a high period, but the action that he referred to was a slow, deliberate worming around of the edge. At a definite point of diminished speed it would go dead again. They could produce this snake-like motion at higher speeds, and as the wheel was slowed down to a certain limit it would begin to get less and finally stop, and they could not reproduce it without going to the higher speed. Although the stiffer wheels were all very limber, made of rubber, and just a little bit thicker at the edge, they could not produce this effect in them at any speed at which they would stay upon the shaft. The turbine wheel in a state of elastic distention may do exactly the same thing, and instead of going around like a slowly crawling snake it may go at a higher rate of speed, but they do not know.

Slight Stiffening Avoids Vibration

Generally speaking, tendencies to vibration, and particularly tendencies to injury through vibration, diminish very rapidly as the object is made stiffer, because the local strain produced by a certain amplitude of vibration is simply a question of the degree of elongation of the particles on the surface. Their amplitude of motion, their degree of elongation, is very minute, and consequently the strain imposed is very small, and the natural period increased in a normally rapid rate by stiffening the blade and reducing the strain in it at the same time. Consequently, a stiffened disk tends to go dead quite suddenly.

He could not say mathematically as to these limits, but he could say this: The adoption of such light wheels was distinctly against his judgment. They had a premonition of the possibility of such motion several years ago in connection with very large-diameter machines 1200 revolutions, and he had repeatedly warned them to keep the heavy construction on wheels to avoid the possibility of such motion, but there is some difference of opinion as to the cause, and as he does not directly control the turbine designing any longer and this matter rather got away from him, he did not realize quite the extent to which the thing had gone.

The lightening of these wheels was largely a question of the use of a very light method of bucket arrangement which made the rim of much less weight, and greatly lightened the web, and the lack of stiffness in the rim, as well as in the web, would conduce to this tendency to vibration. These rubber wheels showed that it was only with the light rims that they did it. In the case of the wheels with the heavier rims they could not make them distort.

Compound No Better Than Two Separate Smaller Units

Mr. Berg had said in his paper that the generators simply can be made within the limits of the possibilities of the turbine. That applies, of course, to a turbine of the type of which he speaks, but if one made a double low-pressure turbine of the same speed, he would soon get beyond the capacity of the generator, and Mr. Emmet did not think there is very much practical advantage in trying to build a turbine up to the capacity of the generator in that way. A double-flow turbine of the same type could be made of twice the capacity, but it would not be any more efficient and would be quite complicated and large. It might be found necessary to have two generators, and probably would, and he thought it better to keep to a reasonable size and have independent turbine units.

Large General Electric Turbine

W. J. Foster said that Mr. Newbury had asked him to tell of the largest generators that have been built by the General Electric Co. About five years ago there were three 30,000-kw. 25-cycle generators put into operation, one of them a little over five years ago, and two others following closely. These ran at 1500 r.p.m. Since that time there has been one 35,000-kw. 25-cycle, and one of approximately 29,000-kv.a. at 90 per cent. power factor, which has been in operation for one year. There are several 35,000-kw. units now in operation.

In the 60-cycle line there are several 250-kv.a. 80 per cent. power factor, 3600 r.p.m., one 7500kv.a. 6000-kw. 80 per cent. power factor that has been in operation about one year, and they are being built up to 9375 kw., all of these 80 per cent. power factor.

In the 1800-r.p.m. class they had quite a number of 31,250-kv.a. 80 per cent. power factor, and some 33,333-kv.a. at 90 per cent. power factor, 30,000 kw. and are building 40,000 kv.a.'s at a power factor of about 85 per cent. The 60 cycles are all 80 per cent. power-factor machines approximately.

Mr. Newbury's curve, which Mr. Foster thought was an excellent one and scientifically correct, is based apparently on 80 per cent. power factor, and Mr. Foster's experience agreed with Mr. Newbury's statement that the limit is reached in the rotor and not in the stator with these high-speed generators, and that it is all a matter of power factor. If we remove the power factor from Mr. Newbury's curve and draw it upon a new power-factor basis, it can be raised about 20 per cent., provided the stator is amplified to take care of it. In his experience there is no trouble, with such temperatures as Mr. Newbury mentions, in at once going to 20 per cent. higher output on that curve for a given speed. It has been his experience to design generators for lower temperatures. They are in the 105-deg. class, and not in the 150-deg. class, and that is also true in the case of practically all 60-cycle generators that have been built up to date.

Mr. Foster did not understand why Mr. Behrend considered the matter of eddy current so formidable. It may be impracticable to design a machine so as not to have some eddy current, but there is no need of having them in anything like such quantities as to imperil the life of the machine, or to cause excessively high temperatures.

HIGH VOLTAGES NECESSARY FOR HIGH CAPACITY

The higher we go in capacity the higher the voltage must necessarily become. If we should build 90,000-and 100,000-kv.a. generators, it would be very difficult to build them in less than the highest voltages that we are now building generators for 30,000 volts. He thought it would be possible with 1200 r.p.m. by new equipment, but not making such a radical change as we made six or eight years ago, when we stepped up to 30,000. It may be possible at the present time to build 90,000-kv.a. 1200-r.p.m. machines. Mr. Foster thought that radical ventilation presented greater possibilities. The larger size of radial ventilation involves larger surfaces for the cooling media to remove heat from the iron and from the windings, the coils being exposed at short intervals, large areas of them exposed to the air, and then such a large surface of the core itself that heat removal is far more effective than in anything he could conceive of as practicable in axial ventilation. The holes for the air to pass axially cannot be right in the teeth, nor very close behind the teeth, except at the core surface. If the area of the holes is figured, it will be found extremely small in comparison with the area that surrounds the two sections for radial ventilation.

ALEXANDER M. GRAY, in discussing Mr. Newbury's paper, gave a summary of the design of a 70,000-kv.a. single-shaft machine with a rotor 51 in. in diameter, operating at 1800 r.p.m. Mr. Gray pointed out that the rotor diameter in such a machine is limited by the hoop stress in the end-connection retaining rings, and not by the disk stress. The stress in a coil-supporting ring 51 in. in diameter, due entirely to its own weight, is 15,000 lb. per sq. in. In addition to this it must support the ends of the coils. The maximum rotor excitation is limited to about 1000 ampere turns per pole per inch of rotor diameter, or 51,000 for a 51-in. machine. Machines are in operation with the stator ampere turns per pole as large as 0.6 maximum rotor excitation. This would limit the rotor excitation of the 51-in. machine to 30,000 ampere turns per pole. Operating the stator of such a machine at a tooth density of 100,000 lines per square inch, the machine will be capable of developing about 450 kv.a. per inch of iron. Axial length of the rotor is limited by alternating bending stresses in the bearing journals. With the bending stresses limited to 5000 lb. per square inch, the length of the rotor between bearings will be 310 in., and the effective length of the rotor will be about 230 in., making the output about 70,000 kv.a. In his closing remarks Mr. Gray said: "I do not suggest that a machine such as the foregoing should be built. There will be undoubtedly manufacturing trouble, due to the length of coils, and also trouble due to movement between conductor and insulation, because of the increase of length with increase of temperature. It is possible to reduce the length of the machine, and the various factors in the above summary are open to attack."

R. B. WILLIAMSON, in his discussion on Mr. Newbury's paper, considers the mechanical considerations are equal to, if not of greater importance than the electrical features in the single-shaft turbo-alternator, and since the two are more or less antagonistic to each other, the design as a whole must be a compromise. In the high-speed machine the maximum output is limited by the rotor, while in large slow-speed machines the stator becomes the limiting factor. Mr. Williamson agreed with the author of the paper that a peripherial speed of 400 ft. per sec. is as high as it is advisable to run a carbon-steel rotor, but if rotor cores are made of alloy steel, higher stresses might be allowed, and a larger limiting output obtained. Steel of the latter kind, when used in large masses, is very liable to develop cracks, and at present is not reliable for the purpose. Mr. Williamson called attention to the output of 10,000 kv.a. for machines operating at 3600 r.p.m. as being something that so far has not been accomplished, although machines of 7500 to 8000 kv.a. are in regular commercial service, but that if it were considered desirable from the steam end of the unit there is little doubt but that it will be possible to design a support for a 10,000 kv.a. 3600 r.p.m. rotor.

FRANCIS W. HODGKINSON asked, "Why should not any of the turbines which have been described have their diameters increased little by little, more length of blades, and have their capacity increased in proportion? There is no reason why not. Why is it not done? Principally because of personal judgment as to where stresses, etc., should cease, not necessarily the calculated stresses, the centrifugal force, but these obscure things that Mr. Behrend spoke about.

"There can be no definite lines drawn as to what stresses you should put any given materials to or what chances you should take. Sometimes some of us are in rather unfortunate positions, and have pressure brought upon us, and must use our best judgment and then go a little further because of that pressure. Mr. Behrend touched on some real truths. He referred to a turbine built by competitors of the company that I represent, but I venture to say that none of the disks would stand the abuse that Mr. Behrend pointed out. I believe they would bend over. What has that to do with any vibratory stresses continually going on there, which, if slightly above the elastic limit, must result in rupture?" He did not want to be understood as saying that the vibrations do that, but the bending stresses he did not think were of so much importance as Mr. Behrend thinks they are.

Mr. Emmet referred to a power station in which single units were employed as compared with cross-compound units. Mr. Hodgkinson had personally favored these cross-compound units, for the reason of simplicity. A turbine working with high pressures at one end and low vacuum at the other calls for skill in designing the distribution of the metal so that expansion and contraction shall be uniform and no distortion result, and any simplification of the circuit is an advantage. By cutting the steam cycle in two, also cutting the temperature range in two, there is a distinct simplification. Many people regard it as a redundancy because there are twice as many bearings. Bearings do not give any trouble, but the simplicity of the circuit does mean something, and in order that different speeds may be employed you can prepare a design of turbine wherein the high-pressure element will run at one speed most suitable to it, and the low-pressure element can run at the most suitable pressures of steam that are involved

HEAT-TREATED ALLOY STEEL DISK NOT THE SAFEST

B. G. FERNALD said that the limit of stress to which the rotor material is subjected in Mr. Johnson's paper is 20,000 lb. per sq. in. when operating at a speed 20 per cent. in excess of the normal. The elastic limit of the material which he uses is about 22,000. Mr. Berg brings out the fact that the maximum stress in the hub and web of his rotor wheels is now 23,000 and 23,500 lb. respectively, and he uses a nickel-steel disk quenched and tempered—in other words, heat-treated—which shows an elastic limit of 55,000 pounds.

On the face of it the element of safety would seem to be with the heat-treated alloy steel disk, but for reasons given by Mr. Berg that is not the case. He wondered if anybody had had an experience that would enable him to tell if a disk of such sizes as are here contemplated can be heat-treated so that one knows when one gets through that the disk is free from shrinkage stresses.

B. A. BEHREND said that the reason for a test of the durability of the material, and vibratory stresses, is that vibratory stresses need not be resonant stresses. Vibratory stresses are all stresses which change in direction. If resonance occurs freely, there will be rapid distortion. Where there is no resonance, the period may be extended from five to ten years.

COMFORT A. ADAMS said that Mr. Behrend might be cheered to know that a very elaborate series of fatigue tests is now being started, on which it is expected to expend $40,000 a year for three years. They are being carried on by the University of Illinois under the Engineering Division of the National Research Council. Mr. Adams thought that Mr. Behrend, in pointing out the dangers of vibration, had spread the danger over a rather large field and without sufficient discrimination. What he says about synchronizing or nonsynchronizing of force and free vibration is quite true, but there are few forced vibrations in the turbine, properly balanced and properly centered, which involve stresses beyond the elastic limit.

Fatigue Stresses Not Dangerous if Within Elastic Limit

It has been assumed that if fatigue stresses are within the elastic limit they are not dangerous. The real dangerous stresses in a disk of this sort are not those due to forced vibration, but are those that synchronize with the natural period of the disk. A very little change in the design, or a slight thickening of the disk, may make all the difference in the world. The danger of rigidity or brittleness as distinguished from these defects may be a safeguard. In so far as the danger is increased with this brittleness, it may change the period of vibration and bring one into the safe realm, rather than into the danger realm. It is possible that the ductility itself may be a source of danger, provided it is accompanied by that increase of elasticity which will cause the vibration to hit the natural period, so that it is a danger which can be spread in a generous way over the whole landscape without discriminating,

Mr. Emmet called attention to the fact that the stresses mentioned in Mr. Berg's paper, of between 20,000 and 23,450 lb., were upon steel having an elastic limit of 55,000 lb. per sq. in. and a tensile strength of 105,000 lb. per sq. in. This is an exceedingly ductile nickel steel, and the stress is a very moderate one. In connection with the matter of vibration, he said that one must have elasticity. The point that he had before made was that if you have a mass of copper below the rings and the mass of copper is extremely dead, the ring cannot vibrate without the copper vibrating.

Farley Osgood said that he had not heard very much said from the operator's standpoint in this situation, and that the poor operators apparently are the victims of the enthusiasm of the designers. It gave him some consolation to hear less talk of 50,000-and 70,000-kw. units. Most of the writers of the papers had confined their enthusiasm to approximately a 30,000-kw. limit as to design.

Continuity of Service

The limiting feature from the standpoint of the operator is, of course, continuity of service, but the success of the designer now makes continuity of service fairly good. Failures are unavoidable in some cases. That means to the operator the loss of the use of the machine. It also means to the operator not only loss in capacity, but loss in the time of use of his machine, and he thought limitations as to size should have that thought as a factor. The writers of the papers bring out quite clearly that very large designs require special tools, special men, and generally factory work when repairs are necessary, which means long delays when these repairs have to be made. He would suggest, from the operator's standpoint, that no design should be made which would require perfection in materials which would in any way lead beyond the point of practical manufacture of such materials, that they should not lead to a point requiring special treatment, so that the product when complete is virtually a special product. The sizes should be confined to such as can be cared for quickly in times of repair and should not be so great as to require enormous investments for spare capacity.

He thought that the manufacturers of these large and costly units know less about their behavior in operation than any group of men in the electrical business. The designer should come and visit the operators. His company was typical of the purchasers and users of large units, but the designers of the two principal companies which manufacture those units have, within his knowledge, spent no time on their property to see how their offspring behaved.

Mr. Johnson, in closing, said, in reply to an intimation that there was greater leakage with the reaction type, that there is practically no difference between the two designs with regard to leakage. In the one type of machine you have a small clearance on the outer diameter, across which the steam may leak, but the pressure difference on opposite sides of a given row of blades is small, so that the steam velocity through it is very slow, whereas on the other type of machine the diameter is smaller, but the pressure difference is greater, and consequently the quantity of steam going through a given area of leakage space is greater. In their 1800-r.p.m. machine of the larger size, which has blades 18 in. in length, the leakage across the last-row figures about 1 per cent., which is practically the same as with the impulse type of machine. He knew of no reason why the reaction type could not be built with the last row of blades operating at the same speed as an impulse type. If you please, you may use the exact construction, changing, perhaps, only the shape of the inlet portion of the blades, and then build a reaction machine from there on up, instead of the impulse machine. The limitation characteristics will be the same. In fact, any impulse machine must of necessity operate as a reaction machine in the last stage if the vacuum becomes sufficiently high to cause a pressure drop through the blades.

Mr. Berg said that the wheel which he had assumed was a very conservative one; the elastic limit there given as 55,000 lb. is about as low as they had ever found in actual test. The majority of the wheels test at 65,000 lb., and they had wheels running at 1800 r.p.m., which were 100 in. in diameter, instead of 88 in.

Mr. Newbury said that he was familiar with the multiple-inlet type of radial ventilation mentioned by Mr. Foster, and in fact had that in mind in the last sentence of the paragraph on ventilation, in which he said: "But with either system of ventilation designers are already finding it necessary to devise more complicated systems in order to take care of 3600 and 1800 r.p.m. rating now in prospect." The Westinghouse company uses both types of radiation, and the same machine can be designed for either type with substantially the same radiating surface. The two machines will be somewhat different in proportion. The radially ventilating machine will be of smaller outside diameter and longer in the core. The axially ventilated machine will be shorter in the axial direction, but will be of larger outside diameter. Mr. Foster was correct in assuming the curve of limiting generator capacities at various speeds to be based on 80 per cent. power-factor machines, and what he said in connection with 100 per cent. power-factor ratings is correct.

Domestic Exports of Pumps and Pumping Machinery, September, 1919

Countries	Dollars	Countries	Dollars
Belgium	19,177	Argentina	13,154
Denmark	3,659	Bolivia	532
France	18,793	Brazil	4,757
Greece	1,560	Chile	14,887
Italy	2,480	Colombia	2,604
Netherlands	24,533	Ecuador	796
Norway	672	British Guiana	4,245
Roumania	29,434	Dutch Guiana	130
Spain	10,224	Peru	10,795
England	55,583	Uruguay	4,284
Scotland	365	Venezuela	2,522
British Honduras	489	China	39,572
Canada	208,325	British India	17,548
Guatemala	1,034	Straits Settlements	100
Honduras	695	Dutch East Indies	14,797
Nicaragua	463	Hongkong	568
Panama	4,588	Japan	27,814
Salvador	34	Russia in Asia	231
Mexico	95,669	Australia	10,553
Miquelon, Langley, etc.	67	New Zealand	11,482
Newfoundland and Labrador	684	French Oceania	175
Barbados	89	German Oceania	13
Jamaica	2,024	Philippine Islands	27,437
Trinidad and Tobago	133	Belgian Kongo	100
Other British West Indies	280	British West Africa	70
Cuba	87,579	British South Africa	12,780
Danish West Indies	837	French Africa	5,486
Dutch West Indies	1,928	Portuguese Africa	1,330
French West Indies	7,008	Egypt	581
Haiti	473	Total	817,348
Dominican Republic	9,126		

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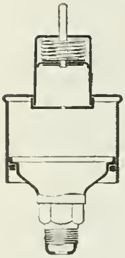
Cup, New Standard Duplex Grease

Standard Manufacturing and Sales Co., 1325 Arch St., Philadelphia, Penn.

"Power," Sept. 16, 1919

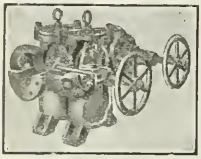


The cup is in two parts, with a diaphragm between, in which is a small hole through which the grease passes into and out of the top portion of the chamber. This contains a spring-actuated plunger, with a stem which protrudes from the top and serves as a sight-feed indicator. The plunger is acted upon by a spring pressure above and the grease pressure below, the grease moving in the direction of the stronger force. The lower portion of the cup is filled with grease and screwed down on the base. The fluid pressure thus created drives grease through the diaphragm, raises the plunger and sets the indicator, and at the same time forces grease through the shank into contact with the bearing. As the grease is used up, other grease automatically takes its place.

Strainer, G-R Duplex

The Griscon-Russell Power Co., 90 West St., New York City

"Power"

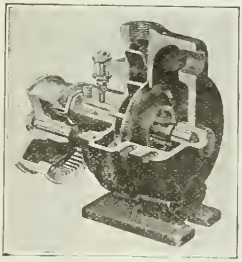


This strainer is designed for installation in the suction or discharge lines of lubricating or fuel-oil systems for the removal of solid foreign material in suspension. It is also suitable for straining river and pond water supply. It consists of a cast-iron body containing two perforated-steel or brass baskets. A valve arrangement permits of the removal and cleaning either basket while the other remains in service. Oil or other liquid enters the inlet connection of the strainer and passes into the basket in service. The solid matter remains in the basket, the clean liquid passing through the perforations thence out of the strainer. All cast-iron sections are cylindrical. The valve mechanism is simple and the valves are easily reground.

Pump, Fulflo

Fulflo Pump Co., Blanchester, Ohio

"Power"

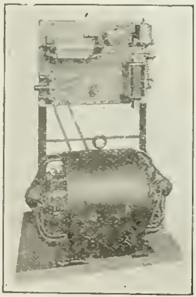


This is a reversing centrifugal pump. The reversing action is accomplished by the design of the volyte and the incorporation of a gate in the discharge, which deflects the water as the pump is reversed from one direction to the other. The gate and the pin on which it is mounted are of bronze, thus eliminating corrosive action. The pump can be run in either direction and can be reversed from one direction to the other, giving instant flow of the liquid being pumped upon starting the pump or reversing the direction. The pad for mounting the pump to the machine base is detachable and can be placed in any one of three positions.

Welding Unit, New Plastic

Wilson Welder and Metals Co., 2 Rector St., New York City

"Power"

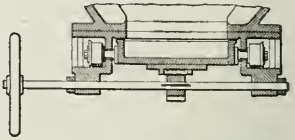


This set is composed of a dynamotor and current-control panel. Generator, flat-compound wound, 35 volts on either no load or full load. The control panel is designed to provide a constant-current controlling panel, small in size, of light weight, simple operation and high in efficiency. On the 20 x 27-in. panel are mounted a small carbon pile, a compression spring and a solenoid working in opposition to the spring. The solenoid is in series with the arc, and any variation in current causes the solenoid to vary the pressure on the carbon pile, thereby keeping the current constant, at the value of adjustment. This outfit is furnished as a dynamotor unit, with standard motor characteristics as follows: 110-220 volts, d.c. or 220-440 volts 60 cycle two or three phase a.c., also as a gasoline-driven unit.

Ashpit Gate, Arrow

Baker-Dunbar-Allen Co., Pittsburgh, Penn.

"Power," Aug. 26, 1919

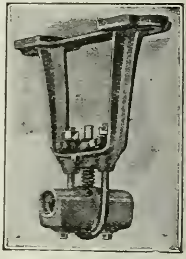


This ashpit gate is made of heavy cast-iron sections having cast-iron rollers. The gate operates on lubricated bearings and is made in sizes that will take care of any openings from 18 in. square to 3 x 5 ft. This permits the opening in the hopper to be made larger than the opening in the dump plate, and therefore anything that passes the dump plate will pass through the hopper. The gate closes against machine metal surfaces and automatically compensates for wear. It is lined with brick and may be hand, motor or piston operated with air, water or steam.

Hangers, Barry Shafting

Barry Co., Muscatine, Iowa

"Power"

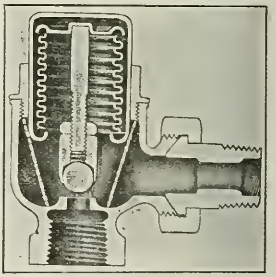


The main feature of this hanger is that the bearing is suspended from a hanger frame by a loop, the two ends of which are threaded. The hanger has an adjustment of 2 in. which is conveniently made by the nut shown and the adjusting screws. One of the features is that headroom is saved, owing to the compactness of the design. The loop is made of cold-rolled steel. These hangers are made in drops from 7 to 29 inches, and with self-oiling bearings from $\frac{15}{16}$ to $3\frac{15}{16}$ inches.

Trap, Sarco Radiator,

Sarco Company, Inc., Woolworth Building, New York City

"Power"



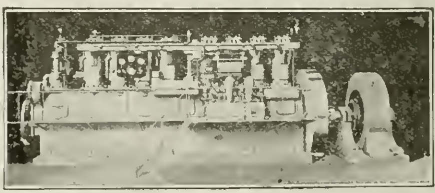
In this trap a spirally corrugated tube with the outer case forms an expansion chamber, which contains a volatile liquid. The inside of the diaphragm is exposed to the steam or vapor resulting in the quick and wide opening and closing of the valve. A strainer is provided to prevent clogging of the valve, and protects the valve head and seat. The strainer has a discharge area about ten times that of the valve itself. The valve will work on any degree of vacuum and on any steam pressure up to 20 lb. per sq.in. without readjustment.

Engine, Winton Oil

Winton Engine Works, Cleveland, Ohio

"Power," Sept. 16, 1919

Diesel type now built for stationary service or direct connection to generators, pumps and also for belt drive. It is built in three sizes with three, four, six and eight cylinders, developing from 50 to 450 hp. Inclosed crank cases, trunk-type piston and crankshaft bearings mounted in the upper half of the crank case with bolted-on cap are the chief characteristics of this engine. Fuel is delivered with a pressure of from 1000 to 12000 lb.



Patented Aug. 20, 1918

Annual Meeting of the American Society of Mechanical Engineers

THE annual meeting of the American Society of Mechanical Engineers, held in New York City, Dec. 2-5, 1919, was especially successful from the standpoint of attendance, there being about 1250 members and 800 guests registered. This record of over 2000 is the largest attendance at any meeting, and is an indication of the interest which is taken in the society.

Headquarters and the Registration Bureau were opened at 9 o'clock on the morning of Tuesday, Dec. 2, and the morning and afternoon were taken up with meetings of the Council and various committees.

At 8:30 p. m. the formal sessions were opened in the Auditorium of the Engineering Societies' Building, with the presidential address by M. E. Cooley. President Cooley's address was a description of the mechanism of organization of the society. He reminded the audience that he, himself, previous to taking office, had been largely unfamiliar with the methods of the organization and assumed that the majority of the members were equally uninformed. The affairs of the society are managed by the Council consisting of the president, six vice presidents, nine managers, the treasurer, and the five surviving past presidents who last held office. President Cooley called attention to the large amount of work required of the members of the Council and expressed warm appreciation of the unselfish way in which they had devoted themselves to this work. There are a number of standing committees to carry on certain continuous functions of the society as well as special committees appointed for special work as need arises. There is a paid secretary with a numerous force of assistants to help in the work of his department. President Cooley remarked that if the members in general knew how far the positions of officers and committee members were from purely honorary jobs, there might be fewer candidates for office.

At the close of the address the tellers of election reported that the Society had elected the following officers for the year 1920: President, Fred J. Miller; vice presidents, John R. Allen, Robert H. Fernald and Edward C. Jones; managers, Elbert C. Fisher, Dexter S. Kimball and Earl F. Scott, and treasurer, William H. Wiley. In this connection it is interesting to note that Major Wiley was elected treasurer of the society in 1884 and has been regularly renominated and reëlected to this position each year since.

After the announcement of the election Major Miller, the president-elect, was escorted to the platform and formally introduced to the members and guests.

ANNOUNCEMENT OF THE ELECTION OF HONORARY MEMBERS

The constitution of the society provides for honorary membership which shall be conferred after a unanimous vote of the Council on persons of acknowledged professional eminence. This is considered the highest tribute the society can confer on an engineer, and the number of honorary members is limited to twenty-five at any one time. James Harkness was given the floor and announced that the Council had elected to honorary membership, M. Charles de Freminville, consulting engineer, Creusot Works, France. Mr. Harkness told of having known M. de Freminville at his home in Paris, during the bombardment of that city by the long-range gun, and of how he had been affected by M. de Freminville's wonderful spirit under those trying times. After President Cooley had formally delivered the certificate of honorary membership M. de Freminville responded, calling attention to the close relations between the engineers of his country and those of our own. Fred R. Low announced that the Council had also elected M. Aguste C. E. Rateau, chairman of the board of directors, Rateau, Battie & Smoot Company, France, to honnorary membership, in honor of his important work in the development of steam turbines and the flow of fluids in nozzles. Mr. Rateau was not in this country so the certificate of honorary membership was handed to M. De Freminville, who promised to deliver it to M. Rateau for the Society.

After the close of the exercises a reception was held for the ladies, members and guests.

On Wednesday morning a business meeting was held. Reports were received from standing and special committees. The report of the Finance Committee showed a total income for the year ending Sept. 30, 1919, of $333,000 in round numbers, or an average of $32.64 per member, based on a membership of 10,200 (the average of the total membership on Oct. 1, 1918, and that on Oct. 1, 1919). The budget appropriations recommended by the committee for the year 1919-20 is $383,000.

The report of the Committee on Meetings and Program noted the constant growth of the spring meetings as an indication of the growing influence of the Society and the hope that the plans for the annual meeting would result in another record-breaking attendance. How well this hope was realized is shown by the attendance figures already quoted.

REPORT OF COMMITTEE ON AIMS AND ORGANIZATION

The Committee on Aims and Organization had presented a preliminary report at the 1919 spring meeting in Detroit and now presented a final report as a result of the discussions at that meeting. Its recommendations were grouped under three headings.

The principal recommendations concerning Society Activities suggested that the Society should adopt a policy of establishing engineering standards and that the constitution be amended to allow such adoption. For help in preparing such standards the Society should increase its interest in research by appropriating more of its own funds and by obtaining funds from other sources, also by formulating problems and securing men and facilities to solve them. The standards adopted should be regarded as progressive, not final standards.

In the matter of education and special training the work in the higher-grade technical schools was approved, but the suggestion was made that much should be done in connection with industrial education below the grade of college work.

The committee persisted in its recommendation that *Mechanical Engineering*, the official organ of the Society, be published weekly. This was objected to at the spring meeting, mainly on financial grounds.

The adoption of a short code of ethics of broad scope, general character and positive rather than negative was urged and it was suggested that a committee be appointed to prepare such a code and report back to the Society.

Other recommendations concerning the details of society organization were made.

The second heading contained recommendations for the formation of a national organization through which the coöperation of local groups, state groups and national societies can be secured for purposes of national scope. Accompanying this report is the report of the Joint Conference Committee representing the four national engineering societies on a national organization. In line with this report the committee insisted on its original recommendation that the national organization should be an independent body.

Under the third heading concerning activities of this national organization the following activities were recommended:

The promotion of legislation for the protection of health, life and comfort, for the development and control of national resources and public utilities and for registration and certification of engineers whose work involves the public well being. The establishment of standards for the production, sale and distribution of commodities. The use of all proper means to secure the appointment of the highest grade men to public engineering positions and close coöperation with such men. The collection of data to help in the selection of engineers to meet public emergency. A dignified campaign of education, in the public press, along engineering lines. Active participation in the solution of the present industrial problems.

Later in the meeting the amendments to the Society's constitution, designed to carry out the committee's recommendations, were ordered to be balloted on the first day of March, 1920.

The Committee on Local Sections presented a very comprehensive report covering the five years of its existence. This committee was organized in 1915, at which time there were only eight local sections, the first two of these, St. Louis and Boston, having been established in 1909. As a result of the activities of the committee and the enthusiasm of the local leaders there are now 31 sections of which one is a state section with five branches, making a total of 35 active A. S. M. E. centers. Coincident with this growth the annual appropriations for local sections have increased from $3500 in 1914-15 to $23,000 in 1919-20. The work of the local sections in the direction of closer affiliation with groups of other branches of the engineering profession is looked upon as an important factor in the development of a national organization as described in the report of the Committee on Aims and Organization.

The Boiler Code Committee presented a preliminary report on Rules for the Construction of Boilers of Locomotives, which are not subject to Federal inspection and control. This report, when adopted, is to be incorporated in the Boiler Code as Part I, Section III, Locomotive Boilers.

MEMORIAL TABLET TO FREDERICK REMSEN HUTTON IN THE ROOMS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Following the reports of committees, announcement was made of the awards of the Junior and Student prizes for papers contributed by members in these two classes. The prizes to Junior members of $50 and diploma were awarded to E. G. Whalen for his paper on "Properties of Airplane Fabrics," and to C. F. Leh for his paper on "An Experimental Investigation of Steel Belting." Mr. Leh's paper was presented jointly with F. G. Hampton who received a Student prize of $25 and diploma. The other Student prize went to W. E. Helmick for another paper on the same subject as that of Mr. Leh and Mr. Hampton.

Unveiling of Hutton Memorial Tablet

Past President W. R. Warner formally unveiled a memorial tablet to be placed in the Society's rooms as a tribute to Frederick Remsen Hutton, who was secretary of the Society from 1883 to 1906, president in 1907 and honorary secretary from 1907 until the time of his death, May 14, 1918. Mr. Warner emphasized the great value of Professor Hutton's services to the Society in its early days. When Professor Hutton first became its secretary, which then meant its active director, the Society, only three years old, had about 400 nominal members, of whom probably less than 100 were effectively active in its affairs. When he gave up the office of secretary, 23 years later, the membership was ten times greater. The financial affairs were in such condition that initiation fees had been treated as current income. The Society headquarters were maintained in Professor Hutton's study at Columbia University. His efforts, ably supported by the stanch founder members, resulted in such growth and prosperity that in 1890 a house at 12 West Thirty-first street was purchased for $60,000. The financing was left to a committee of three, of which Professor Hutton was one. Later he was a member of the joint committee appointed to carry out the generous intention of Mr. Carnegie to provide a necessary building for the use of the several engineering societies.

After his graduation from the School of Mines, Columbia University, he became an instructor in mechanical engineering at Columbia and rose through various steps to be Dean of the Schools of Applied Science in 1899. It was during these years of hard work as a teacher that he found time for his numerous services to the Society. Many expressions from his associates indicate a belief that the success of the Society in those days when it was struggling for existence is due more to Professor Hutton than to any other man.

A memorial pamphlet was presented to the meeting as a tribute to William Kent, who died Sept. 18, 1918. Mr. Kent, who is best known as the author of "Kent's Mechanical Engineer's Pocket Book," was a charter member of the Society. He was for years an active consulting engineer, paying particular attention to boiler and furnace work.

A report of the Committee on the War Activities of members was presented by Major Miller, the president-elect. Major Miller paid tribute to the efforts of the 1400 members of the Society who served in the Army and Navy, especially those who gave their lives in this service.

Wednesday Afternoon Professional Session

On Wednesday afternoon were held the first professional sessions. One of these was devoted to Appraisal and Valuation, which was held jointly with the American Society of Refrigerating Engineers. A second session at the same hour was devoted to Gas Power. Four papers were presented: "The Hvid Engine and Its Relation to the Fuel Problem," by E. B. Blakely; "Kerosene as a Fuel for High-Speed Engines," by L. F. Seaton; "Combustion of Heavy Fuels in Engines of Constant-Volume Type and Super-Induction Engines," by Leon Cammen; and "Oil Pipe Lines," by S. A. Sulentie. The first three papers will be published in abstract form in early issues of *Power*. It is of interest to note that these three papers all dealt in some form with the problem in internal-combustion engines of small size. In Mr. Sulentie's paper the author compares the cost of pipe-line transportation with that of rail and canal transportation and shows the advantages of the oil engine for pumping the oil. He also derives simple formulas for rapid calculations of the pressure and power necessary for such pumping.

A third session was devoted to the problem of industrial unrest and after considerable discussion this session voted to ask council of the Society to appoint committees on the following subjects:

Investment Savings, Credit Capital, Organized Labor, Employees, Managers, Economic and Production Intelligent Service and Committee on the Efficiency of Productivity.

The activities of such committees are intended to crystallize the work already done by the Society on these lines. The wording of the declaration of principles on which this action is being taken is as follows:

"Every important enterprise must adopt competent productive management, unbiased by special privilege of capital or of labor, and disputes must be submitted to authorities based upon intrinsic law.

"Credit capital represents the productive ability of the community and should be administered with the sole view to the economy of productive power; that is, should be granted only to those who are able to render valuable service."

It is believed that this initiative which is unique in the history of professional organizations will have an important influence in fully bringing the facts of the labor situation before the American people.

At 8:30 p. m. a meeting in commemoration of the eightieth anniversary of the meeting of Cornelius De Lamater and Captain John Ericsson, their fifty years of service to this country and the thirtieth anniversary of their deaths. This meeting was the joint effort of fifteen technical societies and civic organizations. Lewis Nixon, public service commissioner of New York, presided. H. F. J. Porter gave an illustrated review of the work of the two men in the De Lamater Iron Works. Mr. Porter told of the meeting of the two young men, of their close friendship and recounted many instances of the growth of the Iron Works. The De Lamater Iron Works was the successor to the Phoenix Foundry, and here were built, largely under the direction of Captain Ericsson, the first iron boats and the first steamers driven by screw propellers, also the engines of the "Princeton," the first United States frigate with engines and boilers below the water line. Much other important work was done here and such naval equipment as self-propelled torpedoes, torpedo boats, submarine boats, etc., were initiated and developed in this plant. The engines of the famous "Monitor" were also constructed here, and rock drills, ice machines, etc., were first made under the direction of these two men.

Following Mr. Porter's address the Hon. C. H. Vezin, Jr., a grandson of Mr. De Lamater, paid a tribute to the memory of his illustrious ancestor, whom he described as a real autocrat in his business, but withal so fair and just that he was respected and loved equally by his associates and employees. The next speaker was the Swedish Minister to Washington, W. A. F. Ekrengren. After outlining Captain Ericsson's achievements and distinguished services in the United States, the speaker said: "While John Ericsson was always faithful to the country which he had chosen as his and did not hesitate to offer her his services and his life, he loved and honored his mother country, Sweden, and never failed to render it a service when he was able to do so. His "Monitor," which he invented long before it came to practical test, was intended for the coast defense of Sweden, and when the first ship of this type was built for the Swedish Navy, he presented to the Swedish government armament for it."

The concluding speaker was Rear-Admiral Bradley A. Fiske, U. S. N., retired. He pointed out the superiority of Ericsson's "Monitor" over the "Merrimac" and that this meant not only that the North would be able to maintain a blockade against Confederate vessels of war, but that it could prevent aggressive action against our country by the most powerful European navies. Mahan's famous book on the "Influence of Sea Power on History" had not then been written, and the attention of the North was so fixed on the movement of armies that the weak point of the Confederacy, its sea communications, was not appreciated and was not attacked vigorously enough. Ericsson's advice was disregarded and much effort was wasted in fighting large, bloody land battles which had no decisive results toward winning the war. Despite the failure to follow it up to the best advantage, Ericsson's "Monitor" undoubtedly turned the critical situation in favor of the North and had an inestimable effect on the history of this country and of the world.

Thursday Morning Session

On Thursday morning, Dec. 4, the session was devoted to "The Industrial Situation in Relation to Present Conditions." The principal paper was by Frederick P. Fish, chairman of the National Industrial Conference Board. Mr. Fish called attention to the need of the utmost efficiency in production and distribution at this time and to the unfortunate lack of harmony in the relations between management and wage earners. As an example of decreased productive power he said that in one plant he found that wages had increased 110 per cent. since 1914, although the cost of living has not gone up more than 75 per cent. and the efficiency of the individual workman has been reduced 40 per cent. in the same period. Mr. Fish criticized the labor unions for their attitude in arbitrarily limiting production, in enforcing the same rate of producton by the good workman as by the poor one and in insisting on dictating their own terms, which were often framed for the benefit of the union and against the interests of the workmen, the employers and the community at large.

He also criticized the management for lack of attention to the proper relations with employees and to employees' working conditions. The same instinct on the part of the public which brought about the more or less warranted attacks on big business twenty years ago will bring about a similar recognition of the danger in the improper exercise of power threatened by the labor unions. If public sentiment is once aroused, the end is certain. The American people will not submit to the domination of any class working solely in its own interest.

The remedy, the speaker asserted, lies in some form of closer relations and better understanding between employees and management. Just how this is to be accomplished must be worked out for each individual plant, as no two present exactly the same problem.

Papers were also read at this session on "Wage Payment," by A. Z. DeLeeuw; "Systems for Mutual Control of Industry," by William L. Leiserson; and "What We May Expect of Profit Sharing in Industry," by Ralph E. Heilman. The discussion of these papers and of the general subject of the session was so prolonged that it was voted to hold an adjourned session in the afternoon so that full discussion might be allowed.

Thursday Afternoon Session

In the afternoon four simultaneous sessions were held Three of these—Machine Design, Power Machinery and Textile —were regular scheduled sessions, while the fourth was the adjourned discussion from the morning session.

At the Machine Design session a paper on the "Reliability of Materials and Mechanism of Fractures" was read by M. Charles de Freminville, the newly elected honorary member of the society. The author called attention to the varying requirements for the properties of materials in different machines or parts of machines. He also described, briefly, methods of studying the behavior of materials by the examination of fractures.

A paper on "Tests on Dredging Pumps Used in Inner Harbor Navigation Canal, New Orleans," by W. J. White, described the design of a two-bladed pump impeller for hydraulic dredging, where this form of dredging had been rendered almost impossible by the great amount of roots and stumps encountered. The result of a number of tests was given to show the success of the new design.

W. J. White presented a paper on "Turbo-Compressor Calculations," in which he developed the mathematical formulas necessary for the design of turbo-compressors. Attention was called to the heating of the gas by friction, impact, etc., in addition to that which is due to the work of compression, and therefore to the increased necessity for cooling with this type of machine.

Two other papers were presented at this session: "A Perfected High-Pressure Rotary Compressor," by C. B. Lord, and "A New Type of Hydraulic Turbine Runner," by Forrest Nagler. Both will be published in abstract in *Power*.

At the Power Machinery session the following papers were presented: "Emergency Fleet Corporation Water-Tube Boilers for Wood Ships," by F. W. Dean and Henry Kreisinger; "Flow of Water Through Condenser Tubes," by William L DeBaufre and Milton C. Stuart; "Air Pumps for Condensing Equipment," by Frank R. Wheeler; "Thermal Conductivity of Insulating Materials," by T. S. Taylor. The paper by Messrs Dean and Kreisinger and that by Mr. Wheeler will be published in abstract in an early number of *Power*.

Flow of Water Through Condenser Tubes

In the paper on "Flow of Water Through Condenser Tubes" the authors give particulars regarding a series of tests recently conducted at the United States Naval Engineering Experiment Station, Annapolis, Md., to determine the friction loss of water flowing through ⅝-in., No. 18-gage standard condenser tubes. The investigations covered variable velocities, water temperatures and tube lengths as well as the effect of both fresh and salt water. A number of sections of 3-in. iron pipe were assembled with flanges. A corresponding number of lengths of ⅝-in. condenser tubing was obtained, and two brass blank flanges were prepared to serve as tube sheets. These tube sheets could be inserted between any two pairs of flanges, thus enabling tube lengths of approximately 5, 8, 11, 14, 17 and 20 feet to be tested. The tubes were held in place by ordinary screwed glands and packed with cotton held between two fiber washers. The water was pumped by a centrifugal pump from a storage tank through a heater and then through the tube. From there it went to weighing tanks and then back to the storage tank. Temperature and pressure were noted at the entrance and exit to the tubes.

From the results obtained the following conclusions were reached:

The resistance with salt water was practically the same as with sea water.

The total resistance may be expressed by the formula, $P = 0.0118\ V^2 + 0.0051\ LV^{1.83}$ (when the average water temperature is 90 deg. F.), where

$P =$ total pressure drop in pounds per square inch.
$V =$ velocity in feet per second.
$L =$ length of tube in feet.

The constants in this equation decrease as the average temperature decreases.

In answer to a question the author stated that no data were available as to the effect on entrance and exit losses when a number of tubes were together, as in ordinary condenser practice. The discussion brought out the fact that most manufacturers are now rounding the entrance to the ferrules to cut down such losses.

The experiments described in Mr. Taylor's paper were undertaken because of the lack of data regarding the thermal conductivity of such materials as are used in the construction of electrical machinery. The results obtained were tabulated for such materials as fish paper, fuller board, cambric, mica tape, various kinds of wood, sheet steel, etc. The results of the experiments may be summarized as follows:

By putting vaseline, glycerin, glue or similar material on the division between two surfaces the thermal drop due to such division may be largely eliminated.

Of the electrical insulating materials tested, those containing mica have in general the better thermal conductivity.

The transverse conductivity of iron stamping can be increased some three or four times by the insertion of some suitable material between the stampings so as to make better thermal contact.

A layer of dust, say coal dust, upon the surface of a body will increase its internal temperature.

The Textile Session

The Textile Section opened with a topical discussion of "Teaching and Training Textile-Mill Employees." Contributions were also presented on the "Mechanical Handling of Stock in Textile Mills." A paper on "Steam Use in Textile Processes," by George H. Perkins, called attention to the use of steam for processes as separate from that for power, and to the lack of technical attention which this subject has received. The various processes were classified in accordance with their use of steam and the factors affecting production and economy were listed. Results of tests were given to illustrate present common practice. In conclusion the author expressed the hope that his outline of the subject would stimulate greater attention to this matter and gave a list of suggestions as lines for study and research.

The session continuing the morning discussion of the Industrial Situation produced considerable written and oral discussion. At the end of the session a declaration of principles was adopted and referred to the Council of the Society. This declaration emphasized the public's interests in industrial questions and insisted that credit capital, which represents the productive ability of the community, should be administered with the sole view to the economy of productive power.

Thursday evening was devoted to entertainment and social matters rather than to professional subjects. Col. E. A. Deeds, Chief of Equipment Division of Air Service during the early development of the air program of the war, gave a lecture on "The Future of Aviation." Colonel Deeds predicted a great future for both military and commercial aviation, but warned against any promised thrills, as progress is bound to be slow, especially in the commercial field. His lecture was punctuated with humorous references to the "Battles of Washington," in which the I. W. W. or "Ink Well Warriors" took an important part.

Col. Thurman H. Bane, Chief of Engineering Division of Air Service and commanding officer of Cook Field, gave a lecture on "Present Development of the Military Airplane." Colonel Bane showed a number of lantern slides and moving pictures just released by the Government.

One of the most interesting of the films showed trials of bomb dropping at the Aberdeen proving grounds. The camera was carried on the plane directly above the bomb and the latter could be seen during its fall and explosion. At the same time the shadow of the machine could be seen on the ground, and the speaker explained that such pictures were used to trace the trajectory of the falling bomb.

Following the lectures the usual Thursday evening dance was held on the fifth floor of the building, while a social gathering and reunion for members and their guests took place on the first floor. This Thursday evening event has come to be looked on as one of the most enjoyable features of the annual meeting and this year's gathering proved no exception.

On Friday morning, Dec. 5, three simultaneous sessions were held under the titles, Transportation, Machine Shop and General.

At the Transportation Session the first paper was "The Scientific Development of the Steam Locomotive," by John E. Muhlfield. In this paper the author discusses at length the scientific factors that have been considered in the design and development of a new, high-powered freight locomotive for the purpose of substantially increasing the average thermal efficiency, as well as the maximum and sustained drawbar pull and horsepower per unit of weight, all of which are now limited by the capacity of the generally adopted boiler superheater.

A paper on "Motor-Transport Vehicles for the United States Army," by John Younger, discussed the types of vehicles best adapted to various military needs.

At the Machine Shop Session three formal papers were presented and an illustrated talk given on "Electric Arc Welding," the latter by H. L. Unland. A paper on "Common Errors in Designing and Machining Bearings," by C. H. Bierbaum, presented ten principles relating to journal bearings. Among these principles are the following:

The advance edge of a bearing surface must be chamfered off in order to permit a supporting film of oil to form.

The oil film forms best on a bearing surface whose advance edge is at right angles to the direction of motion.

Every unnecessary oil groove or interruption in the continuity of the oil film reduces its supporting capacity.

Another important point brought out was that bushings must be made so as to have room for expansion on heating. The author also emphasized the importance of sharp tools in machining bearing surfaces.

Other papers presented at this session were: "Lubrication of Ball Bearings," by H. R. Trotter, and "Thread Forms for Worms and Hobs," by B. F. Waterman.

At the General Session papers were read on "Slow-Speed and Other Tests of Kingsbury Thrust Bearings," by H. A. S. Howarth; "Octaval Notation and Measurement of Binary Inch Fractions," by Alfred Watkins; "Modern Electric Furnace Practice as Related to Foundries," by W. E. Moore; and "An Investigation of Strains in the Rolling of Metals," by Alfred Musso.

During the meeting various excursions were arranged for the members and their guests. Among these were inspection of a telephone exchange switchboard, a visit to the Seventy-fourth Street plant of the Interborough Rapid Transit Company, to the Equitable Building and power plant and to the Navy Yard in Brooklyn. The red-letter excursion was made Friday afternoon to the Curtiss Aëroplane Plant and Flying Field at Garden City, Long Island. Arrangements had been made whereby members could be taken on flights for a nominal sum. This feature proved very popular, for of about 200 who went to Garden City, 105 took advantage of the chance to fly.

Friday evening reunions were held by representatives of the various colleges. This feature has become a regular event, although not part of the Society's official meeting.

The next general meeting of the Society will be the Spring Meeting, which is to be held May 24-27, 1920, at St. Louis, Mo.

Fred J. Miller

Mr. Fred J. Miller was elected president of the American Society of Mechanical Engineeers in connection with the annual meeting in New York, Dec. 2-5, 1919. In selecting Mr. Miller, the Society chose a man who has made an enviable record for himself along the lines of machine-shop and manufacturing practice, as well as in the field of engineering journalism.

Born in Ohio in 1857, he received a common and high school education, which he later supplemented by personal study and special instruction. Turning his attention to machine-shop work, Mr. Miller served a four years' apprenticeship at the machinist's trade, thus obtaining a thorough foundation for his later career in the manufacturing world. For a number of years he worked in various capacities in machine shops. During this time he was a frequent contributor to engineering journals, paying especial attention to articles on tool making.

FRED J. MILLER

In 1887 he left Ohio, where he was working as a tool maker, and came to New York City to become an associate editor of the *American Machinist.* He remained in this position until 1895, when on the retirement of F. F. Hemenway, Mr. Miller became editor in chief of the *Machinist.* This position he held until 1907. For a number of years he was vice-president of the publishing company.

After retiring from journalism, Mr. Miller became associated with the Union Typewriter Company, having charge of the manufacturing end of the business. In this position his thorough training as a machinist and a wide outlook acquired from his connection with journalism, proved its value in helping him to solve the number of manufacturing problems which arose.

When the United States declared war with Germany, Mr. Miller was asked by General Crozier, Chief of Ordnance, U. S. A., to accept a commission as a major in the Ordnance Department. During most of his service he was stationed at the Rock Island Arsenal, where he organized and was at the head of the Civilian Service Division of the Arsenal. Later, he was attached to the office of the Director of Arsenals in Washington, being assigned to duty at the Bethlehem Steel Works, and later still being attached to the office of the Secretary of War. Most of Major Miller's war work was in connection with the personnel in the Ordnance Department and with the settlement of labor troubles. One of his former associates, in speaking of his war activities, says: "It was one of those very important and difficult jobs that was well handled by a good man, but which, being of an unspectacular nature, got no applause for the man who performed it."

After leaving the Government service, Mr. Miller was associated with H. L. Gantt, up to the time of the latter's death in November of this year.

Mr. Miller has always taken a very active interest in the affairs of the American Society of Mechanical Engineers. He became a member of the Society in 1890, and was a member of the Council from 1904 to 1907. He saw service on a number of important committees, and has always taken an active interest in the welfare of the *Journal,* the monthly magazine of the Society which is now published under the title *Mechanical Engineering.* Owing to his long journalistic experience, Mr. Miller has been of considerable assistance in this direction. He served two terms as the Society's representative on the Board of the United Engineering Society and has been chairman of the committee of the Society having charge of the collection of data in regard to members' services for the Government during the war.

Investigation of Fatigue of Metals

An investigation of fatigue phenomena in metals under repeated stress has just been started under the joint auspices of the National Research Council, Engineering Foundation, and the Engineering Experiment Station of the University of Illinois. The Engineering Foundation is providing $15,000 a year for two years for this investigation, and the Engineering Division of the National Research Council is acting in an advisory capacity, largely through its committee on Fatigue Phenomena in Metals. The experimental work is being done in the laboratories of the engineering experiment station of the University of Illinois, under the immediate direction of Prof. H. F. Moore, Research Professor of Engineering Materials and chairman of the committee mentioned.

Plans are laid for a two years' program of tests, and apparatus and materials are already arriving for the tests. It is hoped to secure a considerable amount of data on tests of various metals, including a number of tests of each metal to 100,000,000 reversals of stress. It is hoped to study the various short-time physical tests which are used for metals, such as the impact test, magnetic analysis, and short-time bending tests, to see whether any of these give reliable indices of the ability of the metal to resist fatigue under millions of repetitions of low stress. It is hoped that some reliable commercial test for this important property may be developed by this investigation.

A test party of four or five persons is being organized, and the University of Illinois is fitting up a special laboratory with about 2500 sq.ft. of floor space for the use of this investigation.

National Power Program

"The first step in our power program," says George Otis Smith, the director of the Geological Survey, in his annual report to Congress, "is to get the facts for the country as a whole and particularly for the North Atlantic industrial district. At present, in the central power plants of the country," he says, "water power carries only about 40 per cent. of the load, while the total fuel requirement for steam generated power, including that of the railroads, is not less than 800,000 tons daily. A power program that calls for the immediate and full development of every available and feasible water power, moreover, means saving in both coal and land power, and with this purpose of securing the double conservation, the investigation has been proposed."

In regard to the North Atlantic industrial district project, he says: "Such a unified power system would tie together propperly located steam-electric and hydro-electric plants—old plants that are efficient as well as new plants—in a great power main from which would flow the energy to serve a score of railroads, hundreds of public-service companies, thousands of mills and factories, and millions of homes."

Meeting of the American Society of Refrigerating Engineers

MONDAY, Dec. 1, President George E. Wells, of St. Louis, opened the 15th annual meeting of the American Society of Refrigerating Engineers in the Engineering Societies Building, New York. The morning was devoted to business and to an address by Charles Whiting Baker on the National Department of Public Works and National Service to Engineers. In his address President Wells laid particular emphasis upon the need of further developing the art of refrigeration to meet the increasing needs of industry. He recommended closer study of the work of other national engineering societies to the end that the conduct of the American Society of Refrigerating Engineers might be improved. One of the notes strongly sounded by President Wells was in reference to character building. "The important thing in life is not so much the work a man does as what he gets out of his work," said he.

F. E. MATTHEWS

This year's meeting was noteworthy for the number of papers on the properties of ammonia and brines by members of the technical staff of the United States Bureau of Standards. These were read at the Monday session and were as follows: "Specific Heats of Sodium-Chloride Solutions," by H. G. Barrett and G. S. Taylor; "The Preparation and Purification of Ammonia," by E. C. McKelvy and C. S. Taylor; "Pressure Gages for Precise Measurements up to 100 Atmospheres," by H. C. Dickinson and C. H. Meyers; "Vapor Pressures of Ammonia," by C. S. Cragoe, C. H. Meyers and C. S. Taylor; "The Specific Volumes of Saturated Ammonia in the Liquid and Vapor Phases," by C. S. Cragoe, E. C. McKelvy, D. R. Harper, 3rd, and G. F. O'Connor. These papers are not yet available for publication, having been retained by the authors who will make further studies before the bureau will release them. When it is fully realized how essential are better data on the properties of these substances, the import of the work the bureau is doing in this direction is appreciated. *Power* will publish abstracts of the papers as soon as they are available.

Tuesday morning the session opened with the following papers: "Refrigerator Cars and a System of Transit Refrigeration," by A. J. B. Harris, Chicago, Ill.; "Application of Flow Meters to Refrigerating Work," by H. D. Fisher, Boston; "The Packing House," by Joseph Himmelsbach, New York City.

Subscription luncheons were served in the building.

Dr. Mary E. Pennington opened the afternoon session with a paper on "Balsa Wood," a product of South American forests, used for insulation. The wood is extraordinarily light and, when treated, is quite fireproof. It must be treated immediately after being cut to avoid disintegration by rot. Considerable interest was shown in its cost as compared with other woods and insulators, but all efforts to get specific information from those connected with the paper were futile.

F. L. Fairbanks, Boston, described with the aid of about 100 lantern slides the new T-Wharf refrigerating plant of the Quincy Market Cold Storage Warehouse Co. This plant is fully described in *Power* for Oct. 28-Nov. 4, 1919.

There was no opportunity for further discussion that afternoon.

The dinner followed in the East Ballroom of the Astor in the evening. President Wells acted as toastmaster. Among the speakers were Peter Neff, one of the early presidents of the society, and Dr. Charles E. Lucke, head of the Department of Mechanical Engineering, Columbia University. Professor Lucke said he believed the art of refrigeration was due for an epochal advance. He is not sure but what it is already here in the form of the high-speed compressor electrically driven. It is a logical development, he says, to create electric transmission trunk lines from which much of the refrigerating machinery within the transmission zone may get its motive power. He was highly gratified with the improving coöperation between the physicist and the engineer as exemplified particularly in the papers at the Monday session by the staff of the National Bureau of Standards.

The attendance at the dinner and meeting was, it seemed, unusually large. There was excellent entertainment secured by Secretary Ross. Professor Neumann, the mind reader, performed astonishing feats, Lee Leland and Bobby Jones of the France Packing Co. sang, and Mr. Logan, for many years chief of entertainers at this function, was on hand.

Wednesday morning discussion of Mr. Fairbanks' plant was renewed, the chief participant being Professor Lucke. There followed a paper, "Present Situation of Refrigeration Industry in Russia," by N. Borodin, Russia. The time limit on the meeting room having expired, the two papers, "Conveying Machinery in the Refrigerating Industry," by Edwin McQueen, New York, and "Testing of Household Refrigerating Machines," by Henry L. Lincoln, Chicago, did not come up. The always valuable discussion which comes during the topical discussion of data was also laid over.

The meeting then went into joint session with the American Society of Mechanical Engineers in the Auditorium, where President Wells presented a paper on "Ice Plant Depreciation," and one on "Depreciation of Insulation" was presented by John E. Starr. At this session the American Society of Mechanical Engineers had six papers, all dealing with valuation and appraisal methods.

F. E. Matthews, well known to the readers of *Power*, is the new president of the American Society of Refrigerating Engineers. H. C. Gardener, of Chicago, was elected vice president, and Prof. Edward F. Miller, of the Massachusetts Institute of Technology, becomes first vice president. George A. Horne of New York was reëlected treasurer. The Council appoints the secretary, who is William Ross, widely known in refrigeration circles.

It is likely that the semiannual meeting of the society will be held with the Spring Meeting of the American Society of Mechanical Engineers, and possibly other national engineering societies will be present.

The *Electrical Review*, London, states that the new hydro-electric plant installed at the Kaubauk mine, Burma, India, is the first of its kind to be erected in the district. Kaubauk is about sixty miles from Tavoy Town, and the scheme is important because it provides the mining company with power for the successful exploitation of the deposits that exist in the Tavoy district. It also furnishes to the wolfram industry in particular, and to the province in general, an incentive to utilize the natural resources of Burma.

About three miles to the southward of Kaubauk and at the top of hills 3000 ft. high. is a natural horseshoe-shaped valley, across the heel of which a dam has been built, which impounds a reservoir that stores 500,000,000 gallons of water. Three miles of pipe line convey the water to the power house, built on the edge of the Kaubauk mine, the last portion of the pipe dropping nearly perpendicular 1800 ft., giving a head of 2094 ft. at the power house. The available energy is 1000 hp., only half of which is being utilized by the generator so far installed. The energy generated operates the machinery on a pump dredge which uses 400 hp., and is also used to drive the ore crushers.

Practical Refrigerating Engineers Hold Convention at Kansas City

FROM Dec. 4 to 6 the National Association of Practical Refrigerating Engineers held its tenth annual convention at the Coates House, Kansas City, Mo. The recent restrictions due to the coal shortage interfered to some extent with the plans that had been made by the local committee, and reduced the attendance from that anticipated. Nevertheless the convention was a decided success, due primarily to the interest taken in the subjects presented, and the active participation in the discussion.

Kansas City had been given the convention to encourage the new subordinate recently organized there, this being the first step in a more active program of expansion. Another subordinate has been formed in Chicago, which will have the convention next year, and from now on organization work in various cities of the North and throughout the country will be pushed. It may be stated that the association is on a more substantial basis than ever before, and in its plans for expansion will have the active support and leadership of *Ice and Refrigeration*, which at the present convention was chosen as the official organ of the association.

After registration the first session was called Thursday morning, Dec. 4, with Vice-President J. E. Porter, of St. Louis, in the chair, E. P. Fryant, president of the association, having been unavoidably detained. Routine business, such as reading of the minutes of the last meeting, roll call of officers and appointments of committees, occupied the short period of time available.

In the afternoon four interesting papers were presented. "Refrigeration as Applied to the Manufacture of Ice Cream" was discussed by G. E. Kloss, who reviewed the early days of the industry, when refrigeration was obtained by the chemical action of salt, and traced the development up to the present day, when every large ice-cream manufacturer has a refrigerating plant of considerable proportions. The various refrigerating requirements in lowering the temperature of the milk, in holding, freezing and hardening the cream, were outlined by the speaker.

"Installation of Boilers for the Best Economy" was the subject allotted to J. E. Porter, who dwelt principally upon the construction of the setting and the requirements of a proper foundation. He emphasized the necessity of building the settings from drawings, rather than by verbal instructions. A valuable feature of the paper was the incorporation of data for estimating the quantities of materials needed. Discussion turned to the proper use of buck stays, and the danger of drawing them too tight, so that in the alternate heating and cooling they would tend to crack the setting. The speaker maintained that poor foundations, rather than buck stays, were more often the cause of setting failures. Steel settings, if properly insulated, were approved, but it was the consensus of opinion that brick settings could be made tighter and the radiation would be less.

In outlining what the engineer should do during the off season, Norman Register recommended, first, a durable memorandum book in which notes could be entered during the working season of things needing attention. The speaker outlined in some detail what these various things might be, and then with the list complete, suggested that the cost of the work and the saving that would be effected should be carefully estimated and presented to the manager in a conference called to decide what actually should be done. The discussion of the paper concentrated on methods of blowing oil from expansion coils. Blowing with steam first, and then with air, seemed to be the common practice. There were objections, however, to the internal use of steam and to avoid these, one of the speakers told how he had heated the coils from without with steam and then operated the ammonia compressor as an air compressor to blow out the oil. It was pointed out that the high-pressure end was the place to trap the oil, and with proper operation it should not get to the expansion coils. The small amount of oil that passes the oil traps should get into the liquid receiver, and by means of a regenerator could be removed. Owing to the danger of cracking the fittings, steam could not be used in cleaning double-pipe condensers. The only safe way was to take them down and swab out the pipes.

A paper by C. T. Baker, on the use of electricity in storage houses and ice plants, was read by the secretary, F. L. Brewer. The author strongly recommended the use of electricity in connection with storage houses. The control and operation were more simple. Long steam lines running to a steam engine, with the leakage, radiation and other prevailing troubles, were not to be considered. Owing to the absence of commutator and brush troubles a polyphase induction motor was the type of machine to use.

In the discussion it was brought out that the amount of power required to handle ice to and from storage ranged from 45 to 55 kw.-hr. per ton of ice. Other points discussed were calibration of meters, ammonia receiver capacity, and the equivalent values of oil versus coal as a fuel. A rough figure, commonly accepted, was 3 bbl. of 42 gal. each to a ton of average slack coal. One of the big advantages of using oil was the saving in labor that was possible. Another common figure, liberal in its allowances, was one ton of ice per barrel of oil, although in the discussion figures were given to show that a certain plant had produced a ton of ice on 27 gal. of oil.

Much of the session Friday morning was devoted to lubrication. A paper by C. W. Fryant outlined the usual methods of ordering oil, the prodigal use of cylinder oil, and the difficulty of distinguishing between oils that were approximately correct for the service. The burden of the paper was to trust a reliable salesman, representing a reputable house, to properly select the oil for the plant. In the discussion a single lubricator for the cylinders of all auxiliaries was considered. The oil being fed into a steam header common to the auxiliaries, rather than an individual feed to each machine, had in one case reduced the consumption by one-third. Equal distribution to all machines was questioned, but it was pointed out that if the oil was atomized and became thoroughly mixed with the steam, there would be no question about each ma-

NATIONAL ASSOCIATION OF PRACTICAL REFRIGERATING ENGINEERS IN CONVENTION AT KANSAS CITY chine being lubricated; in fact the machine farthest away would probably receive better lubrication than the nearest, due to the greater amount of moisture in the steam at this point and the better lubrication that could be obtained with moist steam.

In the second paper on lubrication T. B. Phillipo called attention to the extreme temperatures in ammonia-compressor cylinders and the necessity of carefully selecting oil for cylinder lubrication. A straight mineral oil should be used possessing a flash point of 300 deg. F. or over, a cold test of zero or below, and for average operating condition, a body of 150 to 200 sec. of viscocity. One of the main causes of loss in a refrigerating plant was using an oil too light in body. Another cause of loss was placing the oil trap too near the compressor cylinders, so that part of the oil could be carried over in the form of vapor and not given the chance to cool and condense and be deposited in the oil trap. As to quantities of oil required, one quart of oil properly selected should lubricate 5,000,000 sq.ft. of surface swept over by the piston of the ammonia compressor. In the steam cylinders one quart of oil should lubricate 1,000,000 sq.ft. of cylinder surface traveled over by the piston. While the solidifying points of most oils was around 0 deg. F., in some cases it reached 15 deg. below zero, and reference was made to one oil having a solidifying temperature of 31 deg. below zero.

W. A. Converse of the Dearborn Chemical Co. gave an interesting talk on boiler-feed waters, their action and treatment. In a simple way the speaker reviewed the origin of water by evaporation, its formation in clouds, and how contamination first started as it fell through the atmosphere in the form of rain. The speaker then showed how the water assimilated farther impurities after it reached the earth and gave an outline of what these impurities were, dividing them into scale-forming and non-scale-forming ingredients. Typical cases were assumed, the quantity of scale-forming matter determined, and the effects of the non-scale-forming solids, such as sulphate of soda, chloride of soda, etc., by causing foaming and pitting, were reviewed. Various methods of treating the water were outlined. Emphasis was given to the necessity of making a chemical analysis of the water before treatment to determine what chemicals to use.

At the session Friday afternoon Bruce Dodson pointed out the relation of the engineer to plant-insurance costs. The condition of the plant, the layout, the selection of employees for the various duties, provision of safeguarding against accident, carelessness, ignorance, etc., all had an influence on the cost of insurance, and practically all of the items mentioned were under the influence of the engineer. Various good practices, tending to reduce the fire risk, were enumerated by the author, who appealed for co-operation along these lines. It would mean dollars and cents to the industry.

Following the paper was a discussion on raw-water ice. It was felt that the use of this system would increase, as it was necessary to make ice cheaper. With the raw-water system there was not much saving in labor, but a big saving in fuel, and it would eliminate the evaporating equipment. To remove some of the popular objections to raw-water ice, every precaution must be observed to make the blocks clear, one of the great difficulties being to get the employees to pull the drop pipes at the proper time.

Adding hot water from the boiler-feed supply to make up the distilled-water requirements was perfectly feasible if the water had been heated to a temperature exceeding 206 deg. F. Some of the engineers had sprayed this water into the exhaust pipe leading to the condenser, and by reboiling the condensate had obtained excellent results. The possibilities of operating a compression plant in conjunction with a low-pressure absorption system were given some consideration. The leading requirement was an abundance of cool water. Such a plant was cited in which plenty of water at 56 to 58 deg. was available. In this plant 11 tons of ice per ton of coal was produced, and the cost of maintenance was exceptionally low.

Friday evening there was a special lunch and entertainment, but the big feature of the convention, a turkey dinner, was reserved for Saturday afternoon. Saturday morning was devoted to minor changes in the constitution and a discussion on the unification of refrigerating interests. In brief, the plan is to form one composite group of all refrigerating interests, which shall represent the industry in national and international affairs, and have to do with the promotion of the interests of refrigeration in a broader way than can be done by any particular or local organization, a parallel being found in the Chamber of Commerce of the United States of America, as compared to the local chambers of commerce in individual cities. The convention passed a resolution indorsing the plan of unification, and co-operation in fulfillment of the idea. The board of directors was instructed to take steps to affiliate with the proposed centralized body, authority being given them to extend such financial support as the resources of the association would permit.

From a large field of applicants, Chicago was chosen as the next convention city, and the following officers for the ensuing year elected: President, G. E. Kloss, Kansas City; first vice president, C. E. Loker, Chicago; second vice president, J. E. Glenn, Anniston, Ala.; secretary, F. L. Brewer, Pilot Point, Tex.; treasurer, W. R. Ilch, Kansas City, Kan.; sergeant at arms, Eugene Gray, Ruston, Ala.

Personals

Capt. Joseph R. Greenwood, recently discharged from the U. S. Army, has renewed his association with the firm of Charles H. Higgins, architects and engineers.

H. W. Philbrook, formerly with the General Electric Co., Schenectady, N. Y., has been appointed district manager of the Schutte & Koerting Company's New York office, 50 Church St.

Joseph W. Roe, formerly assistant professor of mechanical engineering at Sheffield Scientific School, Yale University, New Haven, Conn., has been appointed secretary to Dr. W. F. M. Goss, president of the Railway Car Manufacturers' Association.

Fred W. Duemler, formerly connected with the Uniflow Boiler Co., Philadelphia, Penn., is now with The Bigelow Co., New Haven, Conn., as manager of sales in the Philadelphia, Pittsburgh and Chicago districts. New offices have also been opened at 515 Commercial Trust Building, Philadelphia.

Paul M. Lincoln, for many years commercial engineer of The Westinghouse Company, has resigned from that organization, effective Nov. 1, to enter the consulting engineering field, and in that capacity will have active charge of motor application engineering for the Lincoln Electric Co.

Prof. Auguste C. E. Rateau, of Paris, France, who represented the Académie des Sciences and the Société d' encouragement pour l' Industrie Nationale at the James Watt centenary held in Birmingham, England, last month, had the degree of Doctor of Law conferred upon him by the University of Birmingham.

Charles F. Scribner, formerly industrial engineer with the Colts' Patent Fire Arms Manufacturing Co., Hartford, Conn., and more recently consulting engineer for L. V. Estes, Inc., Chicago, has become associated with the Business Service Corporation of America, Chicago, Ill., in the capacity of vice president and chief engineer.

Engineering Affairs

The Engineering Council has been requested by the Associated General Contractors of America to appoint representatives to confer jointly with them and the American Institute of Architects in regard to the question of "Payment for Estimating." The council has appointed Samuel G. Neller of Chicago as one of three representatives. It is expected that the meeting will be held in Chicago some time in the near future.

The American Society of Mechanical Engineers, Ontario (Canada) Section, held its first meeting on Nov 14. It took the form of a dinner at the Engineers' Club, following which General C. H. Mitchell spoke on some phases of mechanical engineering in the war as observed by him in France and Italy. General Mitchell, who was Chief Intelligence Officer on the general staff of the British expedition sent to the aid of the Italians on the Piave, is dean of engineering at the University of Toronto. A monthly meeting of the section will be held hereafter.

Business Items

The Atlantic Sales Co. has organized as manufacturers' agents, with offices and warehouses at 59th St. and Woodland Ave., Philadelphia. M. F. Knapp and J. C. Vogel are the organizers of the firm.

The Black & Decker Manufacturing Co., Baltimore, Md., has moved its general offices from 105 So. Calvert St., Baltimore, to Towson Heights, Baltimore.

The Frederick Engineering Co. has become incorporated for the manufacture and sale of automatic stokers, steam jet ash conveyors and centrifugal pumps. The works are located at Frederick, Md., and the main office at 61 Broadway, New York City.

The Crocker-Wheeler Co., Ampere, N. J., has just inaugurated a plan of training for its foremen and other factory supervisors which is of considerable interest. A group of 62 men has been formed to pursue a three months' course in modern production methods, which comprises the study of specially prepared text units, the solution of problems relating to the units, and the discussion of this material at six biweekly meetings held after hours in the plant. These meetings will provide an opportunity to bring home the application of the work to the special problems of Crocker-Wheeler Co. production. At each meeting a lecture will be delivered by an experienced production man and the lectures will be followed by a round-table discussion. The course is under the direction of the Business Training Corp of New York City, which supplies the study material and the class instruction.

New Construction

PROPOSED CONSTRUCTION

Cal., Glendale—The City Trustees plan to hold another election to vote on $260,000 bonds to extend the water system and construct a power generating plant, and have sent out a statement advocating 2 wells, 2 pumps and a booster pump at San Fernando Rd. and Grand Ave., cost, $33,500; number of wells and pumps in Verdugo Canyon, $32,000; pumping plant at Grand View Ave. reservoir, $3000; electric generating plant with 100 kw. generator, driven by Pelton water wheel at Verdugo Canyon reservoir, $9700; also various other improvements.

Cal., Mare Island—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will soon award the contract for the installation of an electric light and power system at the Navy Yard, here. Estimated cost, $25,000.

Cal., San Diego—The U. S. Navy Department, Washington, D. C., is having plans prepared for the construction of a power house, in connection with the proposed hospital at Balboa Park, here. Total estimated cost, $2,000,000. F. W. Southworth, c/o Bureau of Yards & Docks, Washington, D. C., Engr.

Colo., Denver—T. H. Smith, 1520 Cleveland Pl., will soon award the contract for the installation of a heating system in the proposed 4 story, 75 x 150 ft. building on 13th Ave. and Broadway. Total estimated cost, $100,000. The Huntington Architect Co., 311 McPhee Bldg., Arch.

Conn., New Haven—Kusterer & Smith, 376 Yale Ave., is having plans prepared for the construction of a 6 story, 60 x 80 x 116 ft. business building, on Court St. A steam heating system will be installed in same. Total estimated cost, $100,000. Frank E. Brown, 11 Autumn St., Arch.

Conn., South Norwalk—H. Jacob & Sons, Belden Ave., Norwalk, is having plans prepared for the construction of a 5 story, 50 x 200 ft. factory, on State St. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ia., Aurelia—The Board of Education, Consolidated District, is having plans prepared for the construction of a 3 story high school. A steam heating system will be installed in same. Total estimated cost, $165,000. W. Gordon, 319 Hubbell Bldg., Des Moines, Arch.

Ia., Corydon—A. T. Gallagher, City Clk., will soon award the contract for the construction of an earth dam, pumping station and filter plant. Total estimated cost, $50,000. M. G. Hall, City Engr.

Ia., Sioux City—The Auto Corporation, 201 Motor Mart St., is having plans prepared for the construction of a 3 story, 175 x 280 ft. tire factory. A steam heating system will be installed in same. Total estimated cost, $200,000. B. A. Rheinstrom, Mgr. Osborn Engineering Co., 2848 Prospect Ave., Cleveland, Engr.

Ia., Sioux City—The Scottish Rite Templars are having plans prepared for the construction of a 3 story, 140 x 255 ft. masonic temple on 12th St. A steam heating system will be installed in same. Total estimated cost, $750,000. Westcott Engineering Co., 111 Washington St., Chicago, Ill., Engr.

Ia., Woodbine—The School Board is having plans prepared for the construction of a 3 story school. A steam heating system will be installed in same. Total estimated cost, $100,000. W. E. Hulse & Co., 210 Masonic Temple, Des Moines, Arch.

Ill., Chicago—Ascher Brothers, 220 South State St., are having plans prepared for the construction of a 1 story, 90 x 90 ft. theatre on State St. near Randolph St. A steam heating system will be installed in same. Total estimated cost, $1,000,000. Henry C. Newhouse, 4630 Prairie Ave., Arch.

Ill., Chicago—The Board of Trade had plans prepared for the construction of a 17 story, 125 x 125 ft. office building on Jackson and La Salle St. A steam heating system will be installed in same. Total estimated cost, $5,000,000. Holabird & Roche, 104 South Michigan Ave., Archs.

Ill., Chicago—The Cosmopolitan State Bank, 1159 North Clark St., is having plans prepared for the construction of a 1 story, 50 x 150 ft. bank on Chicago Ave. and Clark St. A steam heating system will be installed in same. Total estimated cost, $200,000. Schmidt, Garden & Martin, 104 South Michigan Ave., Arch.

Ill., Chicago—The Lincoln Ice Co., 317 North Elizabeth St., plans to construct a 4 story, 75 x 150 ft. ice plant, at 329 North Elizabeth St. A steam heating system and central power station will be installed in same. Total estimated cost, $100,000. Carl M. Almquist, 118 North La Salle St., Arch.

Ill., Chicago—Lubliner & Trinz, 25 East Jackson St., are having plans prepared for the construction of a 1 story, 170 x 225 ft. theatre, on Milwaukee and Sawyer Ave. A steam heating system will be installed in same. Total estimated cost, $900,000. W. W. Ahlschlager, 111 West Washington St., Arch.

Ill., Chicago—Schmidt, Garden & Martin, Archs., 104 South Michigan Ave., will soon award the contract for the construction of a 5 story, 125 x 500 ft. candy factory, on Franklin Blvd. and Homan Ave., for Bunte Brothers, 730 North Monroe St. Complete power and water plants will be installed in same. Total estimated cost, $1,500,000.

Kan., Coldwater—The city voted $35,000 bonds to improve the water and electric light plants. N. T. Baker, City Clk.

Kan., Hutchinson—The Columbia Realty & Amusement Co., c/o M. B. Shanberg, 1818 Grand Ave., Kansas City, Mo., plans to construct a 2 story, 50 x 150 ft. theatre. A steam heating system will be installed in same. Total estimated cost, $100,000. F. C. McIlvain, Kansas City, Mo., Arch.

Kan., Wichita—J. L. Leland, Secy. of the Board of Education 1028 Hendryx St., will soon award the contract for the construction of a 3 story, 88 x 247 ft. school building. Steam heating and ventilating systems will be installed in same. Total estimated cost, $350,000. H. A. Noble, Kansas City, Engr. Lorentz Schmidt, 121 North Market St., Arch.

Mass., Fairhaven—The Atlas Storage Warehouse, Inc., 608 Pleasant St., New Bedford, plans to construct a 1 story, 75 x 200 ft. and a 3 story, 30 x 50 ft. refrigerating plant, here. Estimated cost, $100,000.

Mass., Willimansett (Holyoke P. O.)—The Stevens-Duryea Co., Chicopee Falls, will soon award the contract for the construction of a 1 story factory at Driving Park. A steam heating system and electric power system will be installed in same. Total estimated cost, $800,000.

Mich., Detroit—The Board of Education, 50 Broadway, will soon award the contract for the construction of a 2 story, 58 x 211 ft. school, with a 44 x 62 ft. wing, on Maplewood and Spokane Ave. A plenum heating system will be installed in same. Total estimated cost, $170,000. Malcolmson & Higginbotham, 404 Moffat Bldg., Archs.

Mich., Detroit—The Eastern Motor Sales Co., 404 Gratiot Ave., had plans prepared for the construction of a 3 story, 115 x 143 ft. service station on Gratiot Ave. A hot water heating sysem, boiler, pump and fan will be installed in same. Mildner & Eisen, 924 Hammond Bldg., Archs.

Mich., Detroit—Maurice H. Finkel, Arch., 303 Chamber of Commerce, will soon award the contract for the construction of a 2 story, 38 x 115 x 190 ft. theatre on Grand-River Ave. for H. C. Keywell, 501 Old Whitney Bldg. A steam heating boiler with forced ventilating equipment, etc., will be installed in same. Total estimated cost, $90,000.

Mich., Detroit—M. Kunstler, 394 Virginia Park, is having plans prepared for the construction of a 4 story, 50 x 90 ft. hotel on Adams Ave., E. A steam heating system will be installed in same. Total estimated cost, $150,000. A. D. Shank, 38 South Dearborn St., Chicago, Ill., Arch.

Mich., Detroit—The Western Gear Manufacturing Co., 1040 Scotten Ave., is having plans prepared for the construction of a 1 story, 40 x 86 ft. heat treating plant on Scotten Ave. Electric motors for power will be installed in same. Estimated cost, $30,000. Louis Scisorek, 225 Farwell Bldg., Arch. and Engr.

Mich., Detroit—M. A. Young, 754 Woodward Ave., is having plans prepared for the construction of a 3 story, 60 x 186 ft. sales and service building on Woodward Ave. and Brady St. A steam heating system will be installed in same. Total estimated cost, $125,000. Mildner & Eisen, 924 Hammond Bldg., Archs.

Mich., Grand Rapids—Kent County is having tentative plans prepared for the construction of a 2 story, 125 x 200 ft. juvenile home. A steam heating system will be installed in same. Total estimated cost, $150,000. Clark E. Higbee, County Bldg., Probate Judge. Osgood & Osgood, 8-10 Fulton St. E, Grand Rapids, Arch. and Engr.

Mich., Grand Rapids—The Trinity Methodist Episcopal Church is having plans prepared for the construction of a 2 story, 180 x 180 ft. church. A steam heating and forced ventilating system will be installed in same. Total estimated cost, $200,000. W. E. N. Hunter, 1306 Chamber of Commerce, Arch.

Minn., Chisholm—The city will soon award the contract for the construction of a 2 story, 250 x 300 ft. recreation building on West Lake Ave. A steam heating system will be installed in same. Total estimated cost, $375,000. Anthony Puck, Torrey Bldg., Duluth, Arch. and Engr.

Minn., St. Paul—Theodore Curtis, Curtis Hotel, Minneapolis, is having plans prepared for the construction of a 15 story, 200 x 350 ft. hotel, on Summit Ave. A steam heating system will be installed in same. Total estimated cost, $2,000,000. Long, Lamoreaux & Long, Andrus Bldg., Minneapolis, Arch.

Minn., St. Paul—C. H. Johnston, Arch., Capital Bank Bldg., will soon award the contract for installing a heating system in the proposed 2 story, 240 x 340 ft. business building at 10 South 4th St., for Gordon & Ferguson, 10 South 4th St. Total estimated cost, $150,000.

Minn., Waubun—The Board of Education is having plans prepared for the construction of a 2 story, 65 x 130 ft. high school building. Steam heating and fan ventilating systems will be installed in same. Total estimated cost, $100,000. Kirby T. Snyder, 933 Plymouth Bldg., Minneapolis, Arch. and Engr.

Mo., Columbia—The Boone County Hospital Board had plans prepared for the construction of a 3 story, 40 x 125 ft. hospital here. A steam heating system will be installed in same. Total estimated cost, $100,000. Farrar & Wiser, Kansas City, Mo., Arch.

Mo., St. Louis—The Union Electric Light & Power Co., 124 Locust St., will be in the market for machinery for new $7,000,000 power plant.

Mo., Washington—The city sold $5000 bonds to improve the waterworks system, including a deep well pump and other equipment.

Neb., Clay Center—The Board of Education is having plans prepared for the construction of a 2 story, 85 x 130 ft. high school. A steam heating system will be installed in same. Total estimated cost, $125,000. W. E. Hulse & Co., Hutchinson, Kan., Arch.

Neb., Guide Rock—The city voted $12,000 bonds to extend the electric light plant.

Neb., Lincoln—The Board of Education, 33 Bankers Life Bldg., will soon receive bids for the construction of a 3 story junior high school. A steam heating system will be installed in same. Total estimated cost, $600,000. Fiske & Meginnis, 33 Bankers Life Bldg., Arch.

Neb., Lincoln—The city plans an election to vote on $300,000 bonds to extend water and light plant. Plans include one 10,000,000 gallon pump, one 3000 k.w. turbo generator, one 500 h.p. boiler, etc. Burns & McDonnell, 400 Interstate Bldg., Kansas City, Mo., Consult. Engrs.

Neb., Norfolk—Armour & Co., 208 South La Salle St., Chicago, is having plans prepared for the construction of a 3 story poultry and cold storage plant here. Total estimated cost, $100,000.

Neb., Omaha—The Omaha Cold Storage Co., 801-13 Farnam St., plans to construct a 5 story, 126 x 154 ft. addition to its plant on 8th and Farnam St., to the Omaha Steel Works, 4802 Leavenworth. Total estimated cost, $250,000.

N. J., Asbury Park—A. Pryor, care of Mann & McNeille, Archs., 70 East 45th St., New York City, is having plans prepared for the construction of a theater and dance hall here. A steam heating system will be installed in same. Total estimated cost, $500,000.

N. J.. Bayonne—The city will soon award the contract for the installation of a centrifugal pump at Avenue B and West 56th St.

N. J., Elizabeth—J. A. Jackson, Arch. and Engr., 1123 Broadway, New York City, is preparing plans for the construction of a 3 story parochial school. A steam heating system will be installed in same. Total estimated cost, $125,000. Owner's name withheld.

N. Y., Brooklyn—Bailey's Department Store, 502 Fulton St., plans to build a 10 story, 100 x 200 ft. store building at 302 Livingston St. A steam heating system will be installed in same. Total estimated cost, $500,000.

N. Y., Brooklyn—G. G. Cozine, care of R. T. Short, Arch., 370 Macon St., is having plans prepared for the construction of a 120 x 193 ft. theatre on Crescent and Fulton St. A steam heating system will be installed in same. Total estimated cost, $400,000.

N. Y., Brooklyn—Louis Gold, 44 Court St., will build a 4 story garage and service station on Atlantic Ave. between Franklin and Classon Ave. A steam heating system will be installed in same. Total estimated cost, $400,000. Work will be done by day labor.

N. Y., Brooklyn—The Temple Shaari Torah, care of Kelly & McCarthy, Archs., 16 Court St., is having plans prepared for the construction of a 1 story, 60 x 100 ft. synagogue at 1607 Avenue R. A steam heating system will be installed in same. Total estimated cost, $175,000.

N. Y., Long Island City—G. Piel Co., 29 13th St., is having plans prepared for the construction of a 6 story, 150 x 200 ft. industrial building on 7th, 8th, Washington and Pierce Ave. A steam heating system will be installed in same. C. H. Higgins, 19 West 44th St., New York City, Engr. and Arch.

Ohio, Cleveland—The Cleveland Telephone Co. will receive bids about March 1 for the construction of a 4 story, 90 x 138 ft. exchange building on St. Clair Ave. and East 123rd St. A steam heating system will be installed in same. Power to be leased. Total estimated cost, $250,000. Allard Smith, Engineers Bldg., Mgr. A. N. Symes, 602 Engineers Bldg., Engr.

Ohio, Cleveland—The Cleveland Telephone Co. will receive bids about March 1 for the construction of a 3 story, 90 x 150 ft. exchange building on West 65th St. and Guthrie Ave. A steam heating system will be installed in same. Power to be leased. Total estimated cost, $200,000. Allard & Smith, Engineers Bldg., Mgr. A. N. Symes, 602 Engineers Bldg., Engr.

Ohio, Bellevue—The Collier Motor Truck Co. is having plans prepared for the construction of a 1 story, 60 x 90 ft. assembly plant here. A steam heating system will be installed in same. Total estimated cost, $100,000. E. McGeorge, 1900 Euclid Ave., Cleveland, Arch.

Okla., Broken Bow—The city plans to construct a new electric light plant. Estimated cost, $135,000. Hughes Engineering Co., 304 Bank of Commerce Bldg., Tulsa, Engr.

Okla., Duncan—Stephens County has had plans prepared for the construction of a 3 story, 70 x 84 ft. courthouse on Main St. A steam heating system will be installed in same. Total estimated cost, $150,000. Jewel Hicks, Oklahoma City, Arch.

Okla., Hobart—The City Council has accepted the preliminary report prepared by V. V. Long, Engr., 1300 Colcord Bldg., Oklahoma, for the construction of a dam, 14 inch gravity flow line and pumping station. Total estimated cost, $120,000.

Ore., Wallowa—The Enterprise Electric Co., Spokane, Wash., plans to install a 225 h. p. Pelton wheel and 35,000 lbs. piping for the extension of the light and power facilities here. Estimated cost, $5000. B. Serier, Mgr.

Pa., Allentown—Max Spiegel, Strand Theater Bdg., New York City, is having preliminary plans prepared for the construction of a theater. A steam heating system will be installed in same. Total estimated cost, $250,000. David Levy, 949 Hamilton Ave., Engr. and Arch.

Pa., Oil City—The Columbia Realty Co., Erie, plans to build a theater. A steam heating system will be installed in same. Total estimated cost, $200,000. Arland W. Johnson, 24 East 42nd St., New York City, Engr.

Pa., Philadelphia—The Atlantic Refining Co., 3144 Passyunk St., is having plans prepared for the construction of a 20 story, 80 x 120 ft. office building on Broad and Spruce Sts. A steam heating system will be installed in same. Total estimated cost, $1,000,000. Cass Gilbert, 244 Madison Ave., New York City, Arch and Engr.

Wis., Kenosha—The Frost Manufacturing Co. plans to install its own power plant during the year.

Contracts Awarded

Mich., Detroit—J. McE. Bowman, Hotel Biltmore, New York City, has awarded the contract for the construction of a 23 story, 120 x 255 ft. hotel on Madison Ave. here to George A. Fuller, Penobscot Bldg. A steam heating system will be installed in same. Total estimated cost, $5,000,000.

Mich., Detroit—The Detroit Edison Co., David Whitney Bldg., has awarded the contract for the construction of a 2 story, 25 x 113 ft. electric sub-station on Connor's Creek Rd. near Six Mile Rd. to Albert A. Albrecht, 1130 Penobscot Bldg. Estimated cost, $50,000. Noted Sept. 16.

Mich., Detroit—The Gray Estate, Hammond Bldg., has awarded the contract for the construction of a 2 story, 140 x 189 ft. garage and sales room on Antoinette and Cass Aves. to Frank H. Davies, Penobscot Bldg. Steam heating equipment, consisting of boiler, air compressor, fan, etc., will be installed in same. Total estimated cost, $150,000.

Mich., Detroit—The La Salle Garden Theater Co., c/o C. W. Brandt, Arch., 1113 Kresge Bldg., has awarded the contract for the construction of a 2 story, 106 x 124 ft. theater on 14th Ave., Ferry Park, to Frank Farrington Co., 201 Scherer Bldg. Total estimated cost, $150,000. Steam heating equipment, consisting of a boiler with air washer, motor-driven fans, etc., will be installed in same.

Mich., Detroit—The C. R. Wilson Body Co., Clay Ave., has awarded the contract for the construction of a 2 story, 45 x 100 ft. power house on Clay Ave., to A. A. Albrecht Co., 1130 Penobscot Bldg.

Minn., Minneapolis—The Wallis Coach & Carriage Co., 12 East Grand St., St. Paul, has awarded the contract for the construction of a 4 story, 84 x 155 ft. coach factory on University and Bedford Ave. to Foley Brothers, Gilfillan Bldg., St. Paul. A steam heating system will be installed in same. Total estimated cost, $100,000.

Mo., St. Louis—The Polar Wave Ice & Fuel Co., 3620 Olive St., has awarded the contract for the construction of a 1 story, 47 x 101 ft. ice factory at 1931-35 Vanderventer St. to the Fruin Colnon Contracting Co., Merchants' Laclede Bldg. Estimated cost, $20,000.

Mo., St. Louis—The Scullen Steel Co., 6900 Manchester Ave., has awarded the contract for the construction of three 1 story rolling mills on Manchester Ave. to the Fruin Colnon Contracting Co., Merchants' Laclede Bldg. A steam heating system will be installed in same. Total estimated cost, $200,000.

Mont., Billings—The Crystal Ice & Fuel Co., 15 North 22nd St., has awarded the contract for the construction of a 1 story, cold storage building to Frank Jacoby & Son, 1041½ North 3rd St. Estimated cost, $50,000.

Neb., Omaha—Farrell & Co., 10th and Dodge St., has awarded the contract for the construction of a 6 story, 60 x 106 ft. factory for the manufacture of syrup and cans on the northwest corner of 9th and Dodge Sts. to Peter Kiewit & Sons, 754-56 Omaha National Bank Bldg. A high pressure steam heating system will be installed in same. Total estimated cost, $200,000.

N. J., Edgewater—The U. S. Aluminum Co. has awarded the contract for the construction of an 81 x 450 ft. and an 80 x 176 ft. steel factory to the Turner Construction Co., 244 Madison Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $1,000,000.

N. Y., Brooklyn—Marcus Loew, 1492 Broadway, New York City, has awarded the contract for the construction of a theater on Bay Ridge Ave. and 5th St. to Louis Gold, 44 Court St. A steam heating system will be installed in same. Total estimated cost, $500,000.

N. Y., Greycourt—The Superintendent of the Department of Correction, Municipal Bldg., New York City, has awarded the contract for the installation and completion of the boilers and high pressure piping in the administration building at Greycourt House, to J. Dames & Co., Inc., 1996 Nostrand Ave., Brooklyn. Estimated cost, $10,000.

Ohio, Cleveland—The Auto Carriage Co., West 9th St., has awarded the contract for the construction of a 3 story, 60 x 400 ft. factory on Bedford Ave. to H. K. Ferguson Co., 6523 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ohio, Cleveland—L. Israel, 743 East 91st St., has awarded the contract for the construction of a 3 story, 100 x 198 ft. store, theater and office building on Euclid Blvd. to the Kinsman Builders Supply Co., East 79th St. and Kinsman Rd. A steam heating plant will be installed in same. Total estimated cost, $125,000.

Ohio, Cleveland—The Manufacturers Oil & Grease Co., Century Bldg., has awarded the contract for the construction of a 2 story, 78 x 83 ft. factory to the Watson Engineering Co., 1101 Hippodrome Bldg. A boiler plant will be installed in same. Total estimated cost, $75,000.

Ohio, Cleveland—The Monarch Brass Co., 4613 Payne Ave., has awarded the contract for the construction of a 2 story, 66 x 200 ft. factory on 45th St. and Payne Ave. to the Emerson Co., 1900 Euclid Bldg. A steam heating system will be installed in same. Total estimated cost, $150,000. A. S. Dentsch, Pres.

Pa., Allentown—The International Motor Co., 2302 Chestnut St., has awarded the contract for the construction of a 2 story, 60 x 300 ft. and a 1 story, 300 x 540 ft. factory buildings to the Austin Co., Bulletin Bldg., Philadelphia. A steam heating system will be installed in same. Total estimated cost, $300,000.

Pa., Philadelphia—Folwell Brothers & Co., Inc., 625 Chestnut St., has awarded the contract for the construction of a 5 story, 23 x 101 ft. factory on American and Somerset Aves. to W. Steele & Sons Co., 16th and Arch Sts. A steam heating system will be installed in same. Total estimated cost, $400,000.

Pa., Philadelphia—The Philadelphia Electric Co., 10th and Chestnut St., has awarded the contract for the construction of a 5 story, 150 x 300 ft. power house on Beach and Palmer St., to Stone & Webster, Medical Arts Bldg. A steam heating system will be installed in same.

R. I., Pawtucket—The Jenckes Spinning Co., Weeden St., has awarded the contract for the construction of a 3 story, 48 x 104 ft. and a 4 story, 114 x 174 ft. mill addition to the Willworth Mackillop, Inc., Freeman St. A steam heating system will be installed in same. Total estimated cost, $250,000.

S. C., Wareshoals—The Wareshoals Manufacturing Co. plans to construct a 100 x 125 ft. ice plant. J. E. Sirrine, Greenville, Engr. and Arch.

S. D., Madison—Robert S. Westaby, c/o P. O. Moe, Arch., 616 New York Life Bldg., Minneapolis, has awarded the contract for the installation of a heating system in the proposed hospital here, to the Fitzgerald Heating Co., Madison. Estimated cost, $9000.

Va., Richmond—The Long Ice & Coal Co. plans to construct an ice plant on Brook Rd. Estimated cost, $100,000. Address M. A. Massie, 723 American National Bank Bldg.

Wis., Milwaukee—Hummel & Downing Co., North Cambridge Ave., has awarded the contract for the construction of a 7 story, 100 x 120 ft. warehouse to the Hansen Construction Co., 425 East Water St. A steam heating system will be installed in same. Total estimated cost, $300,000.

Wis., Milwaukee—The Pabst Brewing Co., 9th and Chester Sts., has awarded the contract for the construction of a 5 story, 85 x 210 ft. factory on Chestnut St. to L. J. Voell, 504 40th St. A steam heating system will be installed in same. Total estimated cost, $125,000.

Okla., Elk City—The Board of Education has awarded the contract for the construction of a 2 story, 60 x 195 ft. high school with 2 wings to the Kreipke-Schafer Construction Co., Oklahoma City. A steam heating system will be installed in same. Total estimated cost, $125,000.

Ont., Toronto—The Dominion Bank, Dominion Bank Bldg., has awarded the contract for the construction of a 2, 3 and 4 story, 85 x 93 ft. bank building on Queen and Bay Sts., to Witchall & Son, 156 St. Helens St. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ont., Walkerville—The Peabody Sales Corporation, Ltd., Windsor, has awarded the contract for the construction of two factory additions, 4 story, 80 x 250 ft., and 4 story, 60 x 200 ft., to Wells & Gray, Confederation Life Bldg., Toronto. Present heating system will be extended. Total estimated cost, $500,000.

POWER

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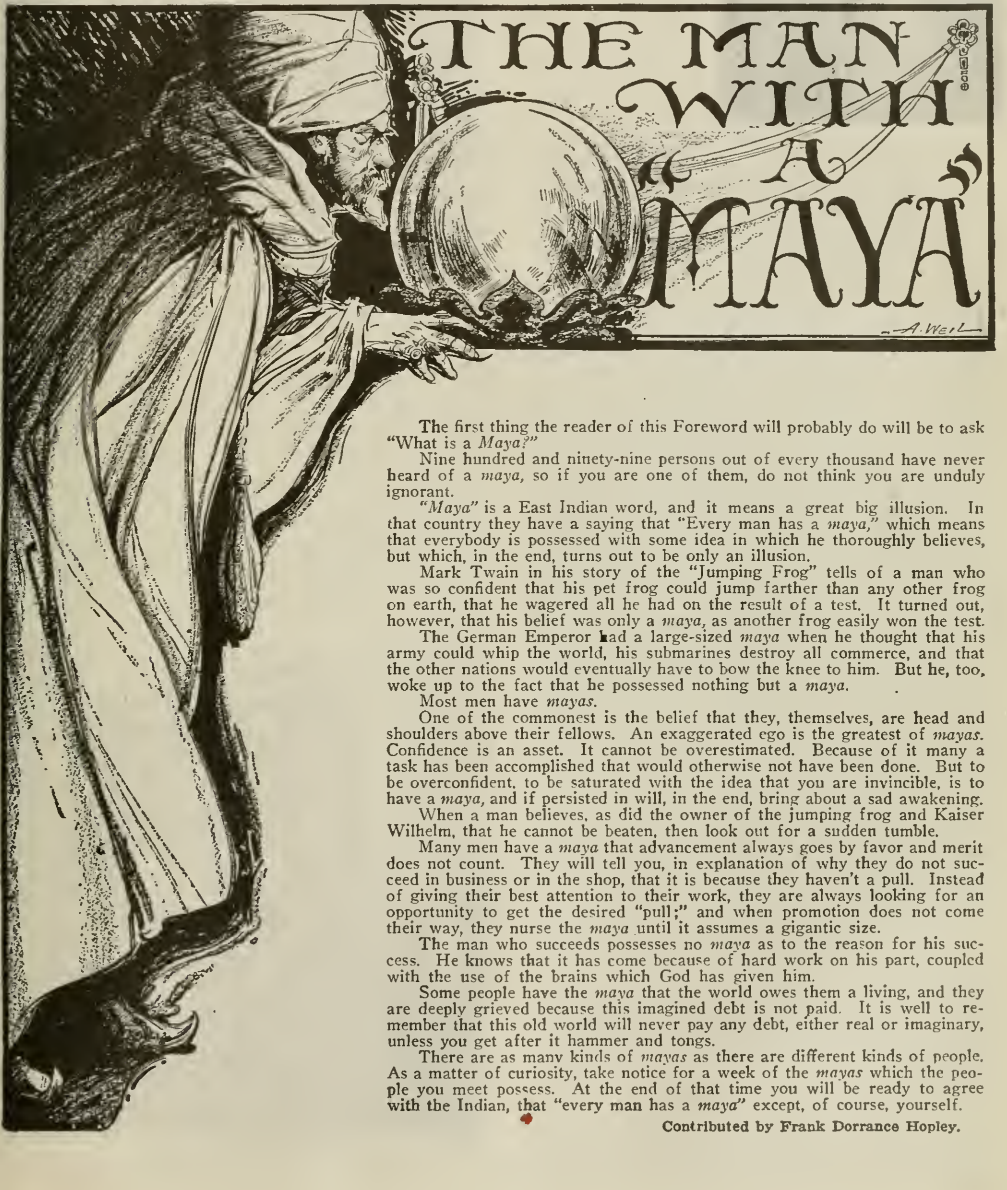

THE MAN WITH "A" MAYA

The first thing the reader of this Foreword will probably do will be to ask "What is a *Maya?*"

Nine hundred and ninety-nine persons out of every thousand have never heard of a *maya,* so if you are one of them, do not think you are unduly ignorant.

"Maya" is a East Indian word, and it means a great big illusion. In that country they have a saying that "Every man has a *maya,*" which means that everybody is possessed with some idea in which he thoroughly believes, but which, in the end, turns out to be only an illusion.

Mark Twain in his story of the "Jumping Frog" tells of a man who was so confident that his pet frog could jump farther than any other frog on earth, that he wagered all he had on the result of a test. It turned out, however, that his belief was only a *maya,* as another frog easily won the test.

The German Emperor had a large-sized *maya* when he thought that his army could whip the world, his submarines destroy all commerce, and that the other nations would eventually have to bow the knee to him. But he, too, woke up to the fact that he possessed nothing but a *maya.*

Most men have *mayas.*

One of the commonest is the belief that they, themselves, are head and shoulders above their fellows. An exaggerated ego is the greatest of *mayas.* Confidence is an asset. It cannot be overestimated. Because of it many a task has been accomplished that would otherwise not have been done. But to be overconfident, to be saturated with the idea that you are invincible, is to have a *maya,* and if persisted in will, in the end, bring about a sad awakening.

When a man believes, as did the owner of the jumping frog and Kaiser Wilhelm, that he cannot be beaten, then look out for a sudden tumble.

Many men have a *maya* that advancement always goes by favor and merit does not count. They will tell you, in explanation of why they do not succeed in business or in the shop, that it is because they haven't a pull. Instead of giving their best attention to their work, they are always looking for an opportunity to get the desired "pull;" and when promotion does not come their way, they nurse the *maya* until it assumes a gigantic size.

The man who succeeds possesses no *maya* as to the reason for his success. He knows that it has come because of hard work on his part, coupled with the use of the brains which God has given him.

Some people have the *maya* that the world owes them a living, and they are deeply grieved because this imagined debt is not paid. It is well to remember that this old world will never pay any debt, either real or imaginary, unless you get after it hammer and tongs.

There are as many kinds of *mayas* as there are different kinds of people. As a matter of curiosity, take notice for a week of the *mayas* which the people you meet possess. At the end of that time you will be ready to agree with the Indian, that "every man has a *maya*" except, of course, yourself.

Contributed by Frank Dorrance Hopley.

Construction and Operation
of a
HIGH-PRESSURE UNDERGROUND STEAM MAIN

By L. T. Merwin* and O. LeFever†

Description of the construction and operation of a 12-in. high-pressure steam distribution line, 5654 ft. long, partly overhead and partly underground, to supply steam for district heating. Details of the solution of problems in expansion, insulation, condensation, etc.

THE Northwestern Electric Co., of Portland, Ore., has recently installed a 12-in. high-pressure steam line to connect its new steam plant with its district heating distribution system. To properly understand the operating and economic reasons that prompted the construction of this line, it is necessary to make a brief statement of the physical layout of the low-pressure system and the steam-electric generating plant—the so-called Pittock Station—of that company.

In June, 1918, there was 78,000,000 cu. ft. of building space connected to the steam-heating lines, with a normal winter demand peak of about 210,000 lb. of steam per hour. This heating load represented approximately the maximum capacity of the central generating station and was actually the ultimate load intended for the system to carry. Since the system was first put into operation in March, 1914, the prospective load for the station has considerably increased owing to building activity in the district covered, and a careful survey made in the early part of last year showed an unconnected but desirable load of some 60,000,000 cu. ft., and this without going beyond the restricted area covered by the present distributing system. At present the company has 57 per cent. of the total load in this district and 55 per cent. of the total revenue.

The Pittock Station supplying the low-pressure steam is a combination steam-electric emergency and central-station steam generating plant. It is in the basement of the Pittock Block—a modern office building covering a block 200x200 ft., lying between Washington and Stark, West Park and Tenth streets. In addition to the functions mentioned, it is the central substation for the distribution of electric energy—both alternating and direct current—for the west side of the city, and is tied to the transmission system of the company by means of two 11,000-volt 5000-kw. three-phase submarine cables under the Willamette River leading to the Albina Substation, the terminus of the 66,000-volt transmission line.

The steam equipment of the Pittock Station consists of six 500-hp. Stirling-type boilers equipped for burning fuel oil, three burners to each boiler. Storage of 1500 bbl. of oil is provided at the station and additional storage of 8500 bbl. in a circular reinforced-concrete tank entirely underground is also provided at Twelfth and Flanders streets and the station tanks are kept filled by pumping from this latter storage through a 10-in. line 2000 ft. long, as well as by gravity feed from tank cars on a spur track at Twelfth and Davis streets.

The boiler header pressure is 185 lb. and carries from 125 deg. to 150 deg. superheat, giving an ultimate temperature of 527 deg. F. The prime movers in the station consist of two 3500-kw. Curtis turbines with 2400-volt three-phase generators connected to the 2400-volt busses of the station. These turbines are one or both floating on the line, the steam end acting as reducing valves for the steam-heating system and the a.c. generators acting as generators and synchronous condensers for voltage control of the Portland district. The turbines are thus at all times in prime condition to carry emergency load and through a simple controlling mechanism automatically maintain a fixed exhaust pressure for the heating system. From this it is seen that the plant is noncondensing and the emergency electric load is carried against the back pressure of the heating system, which was 10 lb. during last winter. The steam

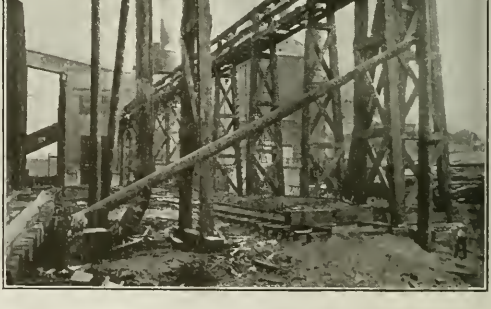

FIG. 1. OVERHEAD SECTION OF STEAM LINE ADJOINING PORTLAND STEAM PLANT

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*General Superintendent, Northwestern Electric Co., Portland, Ore.
†Superintendent of Underground Construction, Northwestern Electric Co., Portland, Ore.

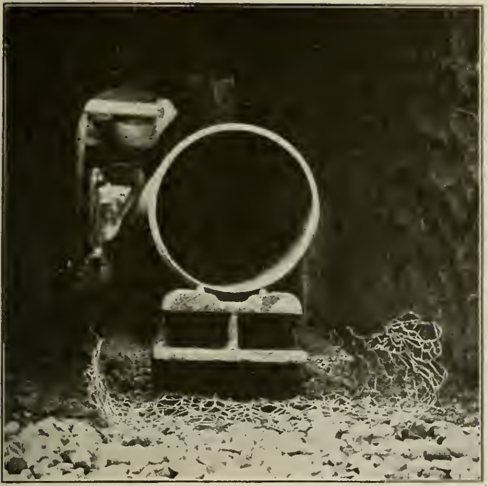


FIG. 2. PIPE SUPPORT AND WIRE MESH FOR TYING CONCRETE BASE TO ENVELOPE

at the turbine exhaust still carries some superheat, and the byproduct electric energy put on the switchboard represents a heat-content loss in the steam of approximately 8 to 10 per cent. The actual kilowatt-hours per barrel of oil under these conditions are about 100. From this it is readily seen that electric deficiency of any great amount cannot profitably be made at this plant, and since a winter duty of 210,000 lb. of steam per hour, on a rated capacity of 3000 b.hp., for steam heating was taxing the station beyond a reasonable duty, some other source than the Pittock Station was needed if the company was to continue to enjoy normal growth.

To meet this demand for steam it was decided to erect a new boiler plant. It is unnecessary to go into the details that finally determined the location of this plant (called the Portland Steam Plant) further than to say that a waterfront location adjacent to one of the largest lumber mills in the district, where mill refuse (hog fuel) was available, was an important consideration. At this new plant "hog fuel" will constitute a considerable portion of the fuel used, and at prevailing market prices it represents an equivalent oil value of from 25c. to 50c. per barrel.

This Portland steam plant was located more than a mile from the district to be supplied by it. It was manifestly impracticable to supply the heating system with low-pressure steam from so great a distance. It was decided, therefore, to install a 12-in. high-pressure main or transmission line from the new plant and connect through a reducing valve to the present low-pressure system. The point of connection was at some distance from the Pittock Station, but with the extension of the 20-in. low-pressure feeder as it is planned, the pressure distribution should be as satisfactory as from that station. This high-pressure steam line connecting through a reducing valve to the low-pressure distributing system is similar to a high-tension electric line connecting through a transformer to a low-tension electric distributing system.

The details of construction of this high-pressure line, some 5700 ft. in length, are of interest. It is designed to carry a pressure of 250 lb. with 200 deg. F. superheat, giving an ultimate temperature of a little more than 600 deg. F. On account of the high temperature and high pressure it was necessary to install extra-heavy steel pipe and fittings throughout. All joints are oxy-acetylene welded excepting at expansion joints, ells, tees, and a few long-sweep bends, where the connections are made with a Van Stone joint. The expansion joints are placed 180 ft. apart and have a travel sufficient to take care of 8½ in. of expansion. The expansion from a dead cold line up to full pressure and superheat is approximately 11 in. per block of 260 ft.

The high-pressure line leaves the new steam plant at an elevation of 34 ft. above ground level, passing over a supporting wooden trestle for approximately 300 ft., where with one horizontal and one vertical bend it drops down to ground level, as shown in Fig. 1. At the power house, or east end of the trestle, an expansion joint is installed, and at the opposite, or west, end a right-angle bend occurs, which is nearly equivalent to a dead end as far as the pull on the line is concerned. Thus, with a 12-in. pipe and 250 lb. pressure we have a west component of approximately 14 tons to be counterbalanced with an east component. At the east end the slip-tube expansion joint has only six 1-in. follower bolts to prevent the line from pulling apart. To anchor the line sufficiently to overcome the equivalent dead-end pressure, heavy bands were welded on the pipe, to which three one-inch stranded plow-steel cables were attached and passed over one of the trestle towers and then down to anchor bolts which pass through a block of concrete weighing about 18 tons. From the end of this trestle the line passes under and up onto the caps of a gradually ascending railway spur trestle, running out from the power-plant yards. The position of the pipe on the railway trestle is between the stringers, just underneath the ties, and above the caps. All the pipe on both trestles is suspended by specially designed hangers.

The railway spur that carries the pipe line reaches an elevation at the west end of approximately 35 ft. above ground level, where it passes over the main-line tracks of the Southern Pacific and the Oregon Electric railways. Just beyond this point the steam line drops down and passes into the underground section for the remainder of the distance to the low-pressure network. This section comprises over four-fifths of the line.

The overhead installation out from the power-plant yards was necessary because a sawdust and decayed wood fill composed the upper surface for a depth of from 30 to 40 ft. The sawdust fill is settling constantly, and to make matters worse, a great many underground springs from the hills above produce a complete saturation of the entire mixture. The footings for the towers of the company's trestle rest on 50-ft. piling.

It would have been preferable to build a special trestle all the way to the underground section, but on account of unsurmountable difficulties in securing right-of-way for a private trestle over the main-line tracks of the Southern Pacific and the Oregon Electric railways, that method was abandoned.

All pipe on the overhead portion of the line is covered with two layers of 1½-in. 85 per cent. magnesia. Around the magnesia is sewed a layer of ducking which is thoroughly painted with a waterproof paint. Over the ducking two separate layers of roofing paper are installed, all joints being broken and sealed with waterproof paint. It is interesting to note that with a temperature of approximately 600 deg. F. on the inside of the pipe the outside of the covering is just perceptibly warm.

The underground portion of the line is laid in a trench 32 in. wide and varying in depth from 4 ft. to 10 ft., depending upon obstructions and the profile of the ground. On account of the large expansion in the pipe, the line is run without breaks as far as possible, and this throws the grade deeper than would have otherwise occurred had grade been broken more often. Any break in grade is a strain point even when anchored securely, and should be avoided where possible. On account of this line being just a little beyond anything yet attempted in underground work, precautions were taken to eliminate, as far as possible, everything that might be a source of trouble.

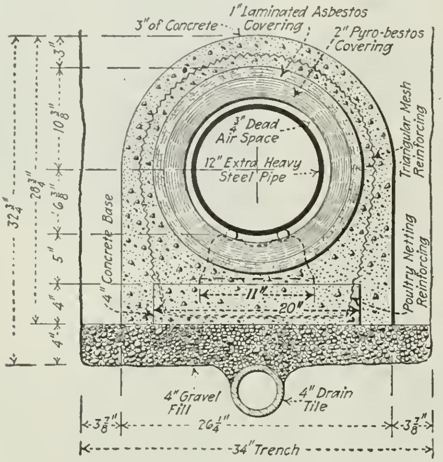


FIG. 3. SECTION OF UNDERGROUND PIPE INSTALLATION

Down the center of the trench and below subgrade is placed a line of 4-in. cement drain tile connected to city sewers wherever possible, usually at the street intersections. Over the top of the drain tile is placed a 4-in. layer of coarse gravel. Next, a 3-in. concrete base is placed to act as a support for the pipe proper.

Supporting pipe guides, as shown in Fig. 2, are placed on the base 9 ft. apart. The top part of the guide contains two semi-circular grooves which act as a path for four 1-in. steel balls which support the entire weight of the pipe. The covering used on the pipe came in sections three feet long, and to facilitate its installation the distance between guides is always on a multiple of three. The guide used weighs 45 lb. and makes a very serviceable and substantial support.

The insulation is shown in section in Fig. 3 and consists of an inner covering of Pyrobestos two inches thick, having a diameter sufficient to allow a three-quarter inch dead-air space about the pipe. The halves of this covering are held in place with bands of No. 22 galvanized annealed wire, all joints being sealed with waterproof asbestos cement. Over the Pyrobestos covering is placed one inch of laminated asbestos, breaking joints with the first layer of covering and having all joints sealed as above. Around the three inches of covering an outside casing of building paper is installed, lapped and tarred on longitudinal and vertical joints to make a water-tight job.

A three-inch envelope of concrete mixed 1-3-5 is then poured around the total circumference of the covering. Tar paper is placed over the concrete and the line is complete, ready for backfill.

The high-pressure line ends on Fifth St., 90 ft. south of the 12-in. east and west main on Yamhill St. A reducing valve preceded by a steam separator and provided with a bypass connection is installed at this point, where the pressure is reduced to 10 lb. The 90 ft. of line between the reducing valve and the Yamhill St. main is 20-in. pipe, provided to slow down the velocity of the steam before it reaches the low-pressure network. The reducing valve was in operation only three or four days when the diaphragm in the pilot valve "went bad." A new diaphragm was made up, consisting of one layer of $\frac{1}{16}$-in. cloth-inserted rubber packing and one layer of $\frac{1}{16}$-in. wire-inserted asbestos, which has given no trouble up to the present time. The cloth-inserted sheet was made up special at the Portland Rubber Mills, using the best grade of live rubber and heavier cloth than used in the ordinary C. 1 sheet. After about 10 days of operation the large main diaphragm of the reducing valve "went bad." A new diaphragm was constructed, consisting of three layers of $\frac{1}{16}$-in. C. 1 sheet (same as above) and two layers of $\frac{1}{16}$-in. wire-inserted asbestos, the rubber and asbestos sheets being alternated. Since the last repair the valve has given perfect regulation. There have been times when the pressure on the high side of the reducing valve would swing from 50 lb. to 70 lb. in five minutes without varying the pressure on the low side of the valve a quarter of a pound. A view of the reducing station before the erection of the bypass valve and nipple is shown at Fig. 4.

A reducing valve is installed at the power-plant end of the high-pressure line, which will ultimately maintain a constant initial pressure, but owing to a mistake of the manufacturers when the valve was shipped the wrong parts for the proper reduction were supplied so at present the high line is floating on the boilers. As soon as this valve is put in operation, the initial pressure will be reduced to about 150 lb. for the light summer load, which will ease up on the line considerably.

There is one feature of the line that has hardly been touched so far, and that is the matter of oxyacetylene welding. This part of the work gave trouble up to the very finish. In all the welding work with standard pipe there was little trouble, but when the welders tackled the extra-heavy pipe they learned that they were up against a different proposition for the surplus heat necessary to weld the extra-heavy pipe made it exceedingly difficult to keep the pipe in line. The method finally adopted was to place the two ends of the pipe to be welded $\frac{3}{16}$ in. apart, and to tack the pipe in five places; even

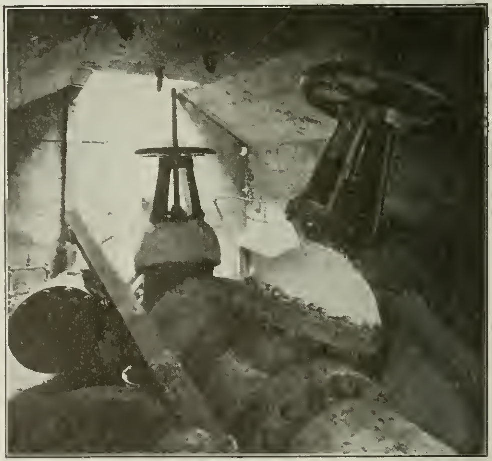


FIG. 4. UNDERGROUND PRESSURE-REDUCING STATION

then, if the welder did not watch himself very closely he was likely to turn out a crooked joint. A hydraulic test of 1000 lb. per sq. in. was put on the line, 180 ft., the distance between two expansion joints, being tested at a time. This test was rather severe, but only one weld on the entire line ever failed under test, although many leaks showed up which required a certain amount of reburning to be done.

The Van Stone flanges previously mentioned came with three feet of pipe attached, having one end beveled for welding. Between all flanges corrugated steel gaskets coated with a commercial pipe cement were used. On starting the line up the first time not a single leak occurred around a flange. However, since the line has been in operation there has been occasion to shut down a couple of times, and each time, on starting up, a leak occurred around a flange. It was found that with the high temperature the pipe cement over the gasket becomes so hard that it is impossible to pull up on the flange bolts and stop the leak, it being necessary to take out the gasket and clean the surfaces before a tight joint can be made. So the gasket is now "doped" with the old reliable red lead, lampblack and oil.

Special care was exercised in the design and construction of the line to avoid traps, as a high-pressure trap on an underground system is generally a source of trouble. Only four traps are installed, two on the overhead portion and two on the underground. A fifth bleeder occurs at the reducing station, but the water at this point is allowed to blow through direct to the low-pressure side through a ½-in. pipe which can be throttled with a globe valve. Under heavy load conditions the superheat in the line more than takes care of the insulation losses, so theoretically there would be no water of condensation, but on account of the exceedingly low conductivity of superheated steam, the film condensation taking place on the pipe walls does not entirely flash back into steam. The traps used are of the bucket type with bottom inlet and top outlet and are very easily installed.

At the reducing station are four direct-reading, long-distance transmitting, pressure gages, two on the high side of the reducing valve and two on the low side. These instruments transmit the high and low pressures, electrically, to recording pressure gages located on the operating floor of both the new steam plant and Pittock Station. Long-distance temperature recorders working on the same principle as the long-distance pressure recorders are to be installed very shortly. Thus it is apparent that the operators at Pittock Station and the new steam plant will at all times know the exact temperature and pressure of the steam at the reducing station and will be able to report immediately any trouble developing in the reducing valve.

One hundred feet beyond the reducing station is installed a back-pressure valve connected to a 12-in. standpipe, 30 ft., high, located just nsiide the curb line. A street-railway trolley pole was replaced with the standpipe, which was painted to match the other poles. It fulfills the dual function perfectly. The back-pressure valve is for emergency use only to relieve the pressure in case the reducing valve fails to operate.

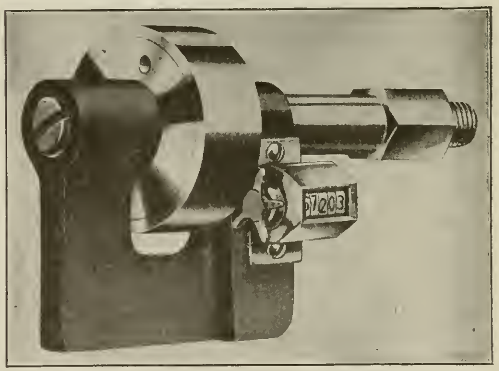
The line has been in operation now for several months and has handled the entire down-town steam load at all times when the electric demand did not require the Pittock Station to pull electric load. As stated in the fore part of this paper, the turbines at Pittock Station run noncondensing and exhaust directly into the low-pressure network. Up to this time there has been no serious operating trouble and the engineers feel quite confident that the line will pull as successfully under full-load conditions as at present. A steam-flow meter will be installed at the delivery end some time in the near future, but until such an instrument is placed there is no accurate method for determining the amount of steam delivered through the new line, but on an estimated load of 140,000 lb. of steam per hour, the drop was only thirty pounds, much less than figured in the preliminary estimates.

No tests have yet been made to determine the efficiency of the covering, but theoretically the line losses will absorb all the superheat until the load passes 40,000 lb. of steam per hour. On several cold mornings temperatures on the low side of the reducing valve reached 360 deg. F. In the company's old type of construction the steam main passes through an asbestos-lined wood pipe casing, and the high temperature of the steam set the log on fire on two different occasions. To eliminate this hazard and reduce the superheat, there has been installed in the steam line three sets of atomizing water jets. These jets will be operated automatically in practically the same manner as the automatic temperature control on a hot-water boiler, but at present are manually operated whenever the steam reaches a dangerous temperature.

Dwight Motion Recorder

A simple and ingenious device designed to record the travel of an elevator, a mine hoist, or, in fact, the movement of any machine having a rotary motion, is made by the Dwight Manufacturing Co., 12 South Jefferson Street, Chicago, Ill. In the case of an elevator the recorder shaft is screwed into the end of the drum shaft, or if it is not desired to tap the center of the shaft, a flange connection is provided, with a ball fitting into the usual center to insure proper alignment of the recorder.

As shown in the illustration, the device consists of an annular ring mounted free on the shaft, two end disks and a counter operated by a pin at the periphery of the ring. The inner disk is attached to the shaft, and rotates with it, imparting its motion to the annular ring by means of a ball clutch between the disk and the inner surface of the ring. If the movement of the drum were always in the same direction, no additional mechanism would be necessary, but in the case of an elevator the up and the down movements balance, so that if the revolutions of the drum in the reverse direction were counted, the readings would coun-



EXTERIOR OF MOTION RECORDER

terbalance and the gage would stand at zero. To obviate this difficulty, the outer disk is secured to the frame and is stationary, but a ball clutch prevents the ring from rotating in the reverse direction. Thus the drum revolutions in one direction only are recorded. Doubling the reading and multiplying by the mean circumference of the drum gives the cable movement and consequently the travel of the car. Where a meter on the cage might register partial trips as full car travel, the present device accurately records the movement.

Knowing the mileage on the car or the cable is useful information. It gives directly the life of the cable, and in reducing power consumption or operating cost to a unit basis, the car mileage is essential. With an electric elevator, power and mileage readings could be taken simultaneously and a comparison of records would show whether the car is operating at or below standard and indicate whether it requires attention. The same reasoning might apply to any other rotating machine or shaft of which it is desired to keep a record.

The device illustrated is intended for use where the revolutions in opposing directions balance. A modification of the meter, however, has been perfected for shafts having a predominant direction. Both forward and backward movement is counted and the total number of revolutions recorded.

Some Considerations of Oil Fuel for Boilers

AT THIS time, when so much attention is given to the use of fuel oil on account of the scarcity and increasing price of coal, the conclusions of the United States Naval Liquid Fuel Board, although made in its report a number of years ago, are as true for conditions today as they were for the conditions at that time, and should therefore be of interest to power-plant men. The report goes on to say that, as a result of the extended series of tests, the following conclusions have been drawn: Our comment appears in brackets.

First, that no difficulty should be experienced by an intelligent fireroom force in burning oil in a uniform manner. It need likewise require but little experience upon the part of the skilled water tenders [or firemen] to be able to detect, either from the character of the roar or hissing noise, or by the color of the flame at different points, an approximate idea both as to the evaporative output and efficiency conditions.

For general purposes on shore, high-pressure steam is a more satisfactory spraying medium than air. The use of steam, however, as an atomizing agent for naval purposes will undoubtedly require a considerable increase in the size of the evaporating plant, and this must be considered of importance. The necessary increase of the evaporating plant is practically the main objection to the employment of steam as an atomizing medium for liquid fuel aboard naval and merchant vessels.

While the use of steam as a spraying medium will undoubtedly prove most satisfactory for general purposes, the results of the tests show that the consumption of fuel oil cannot be forced to as great an extent with steam as the atomizing agent as when highly heated compressed air is used for this purpose. The advantages of air as the best spraying medium for severe forced-draft conditions are due to the fact that this atomizing agent, after entering the furnace, is a supporter of combustion. With the use of steam as an atomizing agent the rarefied vapor simply displaces a certain portion of that air that is requisite for complete combustion. If it were not for the fact that air compressors necessary for supplying an atomizing agent are bulky and heavy and require considerable room for their installation, the question might be considered whether for warship purposes it would not be advantageous to effect an installation whereby either air or steam could be used at will.

In every fuel-oil installation special provisions should be made for the removal of the water that will collect from various sources at the bottom of the supply tanks. Even a small amount of water pumped to the burners will interfere with the efficient and satisfactory work of an oil-fuel installation; as it is essential with every boiler plant to secure a uniform, if not large output, the annoyance and evil of occasionally pumping water rather than oil to the burners cannot be overestimated.

The evaporating efficiency of crude and refined oil is practically the same no matter from what locality the oil may come. The danger of using crude oil, however, is much greater. As it should not be an expensive matter to build refineries near one of the terminal points in a pipe line, the expense of such refining should not increase to a perceptible degree the cost of such oil, since the sale of the byproducts of crude oil would often pay in great part the expense of distillation.

The great benefit of heating air necessary for effecting combustion cannot be doubted.

To provide a uniform supply of oil to the burners the oil should be heated by some simple means. It can be expected that the burners will be operated much more satisfactorily when oil is thus heated, it being understood that the heating has been carried only to the point well below the temperature of the deposition of the hydrocarbon.

Where the use of liquid-fuel installation is projected, there should be a reserve of burners installed, and these burners should be of a design that would permit rapid examination, thorough overhauling and easy renewal of special parts by the fireroom forces. Careful experiments, as well as extended experience, have shown that by increasing the number of burners there is not only a more uniform but a more efficient distribution of flame. There is also a minimizing of the blowpipe effect as well as a marked reduction in the amount of noise in the furnace.

The hygrometric state of the atmosphere has a noticeable influence on the boiler efficiency and capacity.

To secure in oil-fuel installations more uniformity of conditions in the furnace and to decrease the noise where air is used as a spraying medium, an air-cushion tank for the oil-supply pump should be installed. Such a tank would break the pulsations of the pump and serve a similar purpose as the regulating air chamber of an ordinary steam pump.

The board lays emphasis upon the necessity for strainers that are not only adequate to pass the required amount of oil but capable of being easily cleaned.

Extended experience in the burning of crude oil will confirm the opinion that the simpler the furnace the greater its efficiency. The erection of brick arches only tends in many cases to reduce the volume of space necessary for effecting complete combustion. In Scotch boilers there should be a simple vertical brick lining of the back combustion-chamber wall and a lining of the front end of the furnace for about a third of its length. No design of fuel-oil installation should be permitted for marine purposes which would not permit the renewal within twenty-four hours of all grate bars, so that a return to coal could be accomplished within a reasonable time in case of failure of oil supply. In this connection it is interesting to note that in November, 1919, the United States Shipping Board Emergency Fleet Corporation has secured sufficient oil-storage stations along the ocean highways to refuel our merchant or naval ships in any part of the world.

For Scotch boilers the board recommends the use of retarders in the tubes, so as to effect a more even distribution of the gases and the more thorough contact of the total volume of gases passed with the tube surface.

As regards boiler-room labor the board is of the opinion that cheap labor cannot be employed for this work, as there will be resulting damage, annoyance and danger if the operation is assigned to unskilled labor.

The efficiency of oil plants will be primarily dependent on the character of the installation of fittings and auxiliaries. The form of boiler, so long as it is manufactured in accordance with general well-known principles, and all its parts are accessible for overhauling, will play a small part in extending the use of crude petroleum. The method and character of the installation, however, are all-important, and therefore the work of designing and constructing such a plant should be entrusted only to those who have given careful study to the matter and who have had extended experience.

Where crude petroleum has undergone a light refining or distillation, no ill effects result to modern steel burners. (Crude petroleum is not used for fuel purposes today to any material extent. The crude petroleum is topped, the gasolines being driven off.) From the standpoint of endurance of the boiler the advantage, if any, is with oil. Crude oil, however, by reason of its sulphur, and corrosive effect, has a greater tendency than refined oil to attack the tubes of modern boilers.

The value and necessity of installing a series of draft gages between the ashpit at the base of the stack are conclusively shown. As a result of the study of the draft conditions at different points, there were changes made in baffling the gases which were of decided benefit. It is therefore recommended that for experimental purposes a series of draft gages be put into the boilers for observation of the draft conditions at various points.

Practically every form of commercial firebrick that was used in the boiler for the purpose of forming a deflecting arch disintegrated either under the action of the intense heat generated or due to the action of the acids in the oil or coal. In case any form of arch or bridgewall is essential to the efficient or forced burning of liquid fuel, then special experiments should be conducted to secure a refractory brick that would possess endurance under the severest of forced-draft conditions.

[Since this was written some progress has been made in the development of refractory material to stand the high furnace temperature that fuel oil produces. But just as in burning coal on stokers at high rates of combustion, all blowtorch action or its equivalents must be minimized, so too must these be minimized with oil. One should not expect a firebrick to live up under the intense heat produced, for example, by one large burner placed immediately under the tubes or under the crown-sheet sheath of a horizontal return-tubular boiler set low where the heat generated at a short distance from the burner must be equivalent to, and often is greater than, the heat liberated by the expanse of fuel bed that formerly covered the entire grate area.]

For naval installations there should be supplied a fuel oil that will not flash under 175 deg. F. The higher flash point required for naval than for merchant vessels is essential for the following reasons: (a) The war vessel must be kept in readiness to proceed to the tropics on immediate notice, and the firing of guns subjects the naval ship to danger conditions to which other types of vessels are not exposed. (b) The fitting of numerous transverse bulkheads and a protective deck in a naval installation, combined with the fact that both machinery and boilers are exceedingly crowded, make it extremely difficult to properly ventilate certain compartments, and therefore in warships it will be necessary to use special precautions, both in the stowing and in the handling of oil fuel. (c) The fact that a large number of men must be permanently housed beneath decks of the naval ship will make it difficult to prevent the use of open lights in some of the lower compartments, and thus the danger of using oil as a fuel from this cause will always be greatest in naval vessels.

The board lays particular stress on the necessity for a continued supply of oil. Special efforts at the testing plant were required at all tmes to maintain a reserve supply of coal. [For stationary boilers, too, experience has shown, the oil-burning plant should have tank capacity for at least two weeks' supply. In this connection it is interesting to observe that at the plant of the Tamarac Mills, of Pawtucket, R. I., a large oil-burning power station was constructed, with no provisions whatever for the storing or the handling of coal or the storage or handling of ashes.]

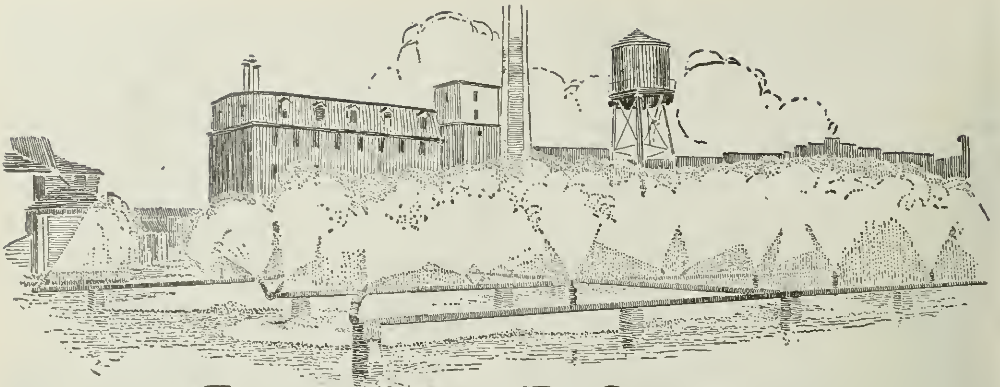
ECONOMICAL ADVANTAGES OF OIL FUEL

The relative evaporative efficiency of oil and coal as a fuel, as determined by this extended series of experiments, is practically in the proportion of 15 to 10. The actual superiority of oil will be considerably greater, for in the coal experiments unusual skill was exercised in the management of the fires. Lump coal of superior quality was used, and as the tests for coal were of comparatively short duration the resulting loss from cleaning fires was much less than would occur in actual service. The oil experiments, however, were carried on under conditions that more closely approximated those that could be secured on board the sea-going vessels. The actual evaporative efficiency of a pound of oil as compared with a pound of coal will, therefore, be at the ratio of 17 to 10, and these figures can be regarded as substantially correct. It will be found, practically, that the thermal efficiency of a pound of oil is the same whether the oil be crude or refined.

The relative efficiency of oil and good steaming coal from the naval standpoint of fuel supply and warships may be regarded as in the ratio of 18 to 10.

The board is, therefore, of the opinion, after special investigation of the comparative merits of coal and oil, that in regard to the evaporative efficiency a long ton of the best quality of coal such, as Cardiff or Pocahontas coal, is equivalent to 4½ bbl. of oil; and that, in a long ton of an inferior quality of coal the evaporative effect will be that obtained from only 3 to 3½ bbl. of oil. This comparison is based upon the assumption that, until greater volume is permissible for the installation of naval boilers, it will not be possible to secure in practice an evaporation from and at 212 deg. F. of over 14 lb. of water per pound of fuel oil. Increased efficiency, however, may be secured by heating the air requisite for combustion.

[It will be seen from the foregoing statements that, in land installations, where it is possible to provide adequate combustion volume, far more than is usually permissible on board ship, the over-all efficiency of the oil-burning boiler should be considerably higher, and in fact is higher, than is possible aboardship.]



SPRAY PONDS

By H. M. Brayton

A study of some of the more important points to be observed in their design and a comparison with the cooling tower.

IN CONDENSING plants where a plentiful supply of circulating water is not available, some means must be provided for cooling this water so that it can be used over and over. Two devices are in use—the cooling tower and the cooling pond or spray pond.

The action of the cooling tower depends mainly on the giving up of heat by the hot water to the air. The tower is usually a high structure, circular in section, with its interior filled with some sort of bafflework designed to break up the water into fine sheets or sprays. The hot water is delivered to the top of the tower while a strong current of air is injected into the tower at the base by means of a forced-draft fan. The air and water come into intimate contact within the tower, and the water is cooled and the air heated. The cooled water from the tower is collected in a basin at the foot, and the condenser water is taken from this supply.

The action of the spray pond depends on the cooling of water by evaporating part of it and thus taking from what was left the heat of vaporization necessary to do the evaporating. Conduction and convection were not relied upon for cooling. This effect is present, also, to a small extent in any cooling tower as some of the water evaporates and carries away heat in the form of steam.

Cooling in the modern spray pond is accomplished, as nearly everyone knows, by spraying the hot water through nozzles designed to break the water up into very fine particles or spray, thus aiding the evaporation tendency. A great deal of experimental work has been done by American engineers in the perfection of these nozzles. At the present time there are several different designs on the market, all of which apparently give good results.

Sprays are arranged in rows and placed a certain distance apart, depending upon the system employed. Theoretically, the farther we place the sprays apart the better the cooling. In practice we are, of course, limited in this respect to the land available and the cost of the pond. These spray heads are attached to the main pipe line either in clusters of five or six, or alone. The rows of sprays are generally placed closer together than the nozzles in a single row. This arrangement is supposed to create a draft between the rows and thus produce better cooling. The general direction of the current of air is upward, however, and this consideration would seem to be somewhat theoretical.

Efficiency of Spray Ponds

About the only way to express the cooling of water in terms of a per cent. efficiency is to compare the amount of cooling that has resulted under a given set of conditions with that which would have resulted had perfect cooling conditions prevailed. By perfect conditions we mean the cooling of the water down to the wet-bulb temperature, which is, of course, the lowest possible to obtain. We may express this in terms of an equation as follows:

$$E = \frac{T_1 - T_2}{T_1 - Tb} \times 100$$

where

E = Per cent. efficiency;
T_1 = Initial temperature of the hot water;
T_2 = Final temperature of the water after cooling;
Tb = Temperature of the wet bulb.

So many factors affect this value that the reader had better consult the paper by Prof. C. C. Thomas on this subject, read before the American Society of Mechanical Engineers at the December, 1917, meeting. The value of Tb may be taken from any humidity table for the conditions under consideration. For rough calculations the reader may use a value of $E = 70$ per cent. and not be far off.

Many people do not realize that the maximum cooling obtainable in a spray pond is dependent on the relative humidity. This factor is more important than the air temperature because it is possible to cool water below the air temperature on days of low humidity. The Spray Engineering Co. quotes tests that show a cooling of 14 deg. F. below the air temperature. The relative humidity stood at 19 during these tests, which is, of course, unusually low. It is more common practice to be able to cool the water to within a few degrees of the wet-bulb temperature. If the engineer will consult

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[*] Mechanical engineer, Semet Solvay Co., Syracuse, N. Y.

the weather reports for the locality in which the pond is to be located and get from them an average value of the humidity for the last few years, he will be able to draw an intelligent conclusion upon the amount of cooling he can obtain.

If the difference between the temperature of the water to be sprayed and the wet-bulb temperature at the given humidity is more than about 20 deg. F., it will generally be necessary to spray the water twice in order to get it down to the desired point. This is undoubtedly due in large measure to the impracticability of placing the spray heads very high above the surface of the pond. There is also a limit to the fineness of the spray which it is possible to obtain, and it is now generally agreed that fineness of spray is more important than a long passage of the water through the air.

When Double Spraying Is Necessary

When it becomes necessary to spray the hot water twice in order to obtain the desired low temperature, two possible cases arise. One of the most common methods is to build two ponds adjoining, with a single wall or bank between them. The water is taken from the hotwell by the pumps and delivered to the sprays in one of the ponds. It is then collected in a sump, usually in one corner of this first pond, and piped back to the pumphouse, where another pump delivers it to the sprays of the second pond, where the final cooling is accomplished. Here again the cooled water is collected in a sump and piped to the condenser pumps, which completes the cycle. Such a system must be arranged so that either pump can deliver to either pond and so that either pond can deliver to the condenser pumps. Either pump must be so arranged that it can draw water from the hotwell. It will usually be advisable to arrange one spare pump in such an installation, so piped and valved that it can take the load of either of the two others when they break down or are in need of overhauling. In winter it will usually be unnecessary to use more than one pond. The climatic conditions locally will greatly affect the details of the design. In such a system we have one pond handling real hot water and the other relatively cool water. The former is quite apt to steam badly, especially on cold days, and if the prevailing winds are in the right direction this spray and moisture-laden air will drift over the other pond, seriously affecting the latter's efficiency. In fact, this trouble may be so pronounced that very little cooling will result in the second pond. It will become apparent at once that in such a design the direction of the prevailing winds is an important consideration. Again, this heavy moisture or fog may injure adjoining property which may or may not belong to the same company.

Mixing Hot and Cooled Water Before Spraying

Another method, when double spraying is necessary, is to mix the hot water from the condensers with some of the cooled water from the pond before it is sprayed at all. This lowers the temperature of the water in proportion to the amount of cooled water added. This mixed water is then carried to the pumps and forced by them to the sprays and requires but one spraying to reach the same low temperature obtained by the use of two ponds. Let us further analyze this arrangement and note its advantages. In the first place, but one pond is required, which saves the dividing wall. But one pipe line need be laid from the pumphouse to the pond. If this distance is long, the saving will be considerable. We have succeeded in eliminating the heavy moisture which was due to the spraying of the hot water. In cold weather part of the sprays may be shut off if properly valved. The reader must not draw the conclusion that a smaller pond is possible with this arrangement. Generally speaking, this would not be true, because the water that is taken from the pond to cool the hot water in the mixing well is really sprayed twice, and so the pumps and nozzles have the same work to do as if the double spraying were done in two separate ponds. If the hot and cooled water were mixed in equal proportions, this statement would be exactly true.

It may be found, however, that it is unnecessary to add equal parts of the cooled water in order to reach the desired temperature. Valves should be so arranged that the operator can adjust this mixture to meet the daily conditions, and he should at no time add more of the cooled water than is necessary to get results from the pond. A thermometer showing the temperature of the condenser feed water, together with a chart showing the temperature possible under the various conditions of temperature and humidity, is all that is needed. Perfect control is then always possible, and even temperature of condenser water means even and maximum efficiency the year around. It may happen that more than an equal quantity of cooled water will have to be added to get results. This would appear on hot, humid days in summer. If the spray system is flexible and has been designed for a little excess capacity, this will be possible and your plant will be able to maintain its vacuum as well as on any other day. This condition would really mean that part of the water was sprayed a third time.

It is of interest and may be of some value to the reader to express in the form of an equation the relation existing between the temperature of the hot, cooled and mixed waters and the quantities involved in each case. We will use the following notation and assume that the specific heat of water is constant throughout the range of temperatures employed. This assumption is almost exactly true. Let

Q = Quantity of hot water from condensers in gal. per min.;

Q' = Quantity of cooled water from pond in gal. per min.;

Q'' = Quantity of mixed water going to spray pumps in gal. per min.;

T = Temperature of hot water in deg. F.;

T' = Temperature of cooled water from pond in deg. F.;

T'' = Temperature of mixed water passing to spray pumps in deg. F.

The following relations must hold:

$$Q'' = Q + Q' \qquad (1)$$

and $8.36\,Q''T'' = 8.36\,Q'T' + 8.36\,Q\,T$. or $Q''T'' = Q'T' + Q\,T$. Therefore

$$T'' = \frac{Q'T' + Q\,T}{Q''} = \frac{Q'T' + Q\,T}{Q' + Q} \qquad (2)$$

The quantity 8.36 used in these equations is the number of B.t.u. required to raise one gallon of water one degree. Note, however, that this value 8.36 cancels out in all members of the equation. Also note that the quantity has been considered in gallons per minute, but that the equations are entirely independent of the unit of quantity, as well as of the unit of time, as long as the same unit is used throughout. In other words, the quantity may be in cubic feet or pounds, and per minute, per second per hour. It makes no difference in the final result, which is the obtaining of the temperature of the mixed water.

It may well happen that the designer or operator desires to know the value of Q'; that is, the quantity of cooled water from the pond which will be necessary to obtain a certain temperature of the mixed water. Equation (2) may be rewritten for this purpose in the following manner:

$$Q' = \frac{Q\,(T - T'')}{(T'' - T')} \qquad (3)$$

Such an equation would prove of value when the line from the pond to the hotwell was equipped with a meter. It would aid the operator in quickly arriving at the desired amount of cooled water necessary to obtain results.

Depth of Pond as Affecting Efficiency

There is another factor which affects the efficiency of a spray pond, and that is the depth of the water employed. Of course, the more shallow the pond the greater will be the area exposed to radiation and conduction in proportion to the body of water. This would seem to be an asset. Experience has shown, however, that a deep pond is the more desirable, when possible, because of the lag in temperature between day and night made possible by the smaller surface exposed to the heat of the sun and the larger body of water. The pond will cool down considerably during the night and will not rise to as high a value during the day in the deep pond. This lag will keep the average temperature of the pond during the twenty-four hours several degrees below the average for the shallow pond. This is a decided gain. On the other hand, the deep pond costs more to build and the designer must strike a balance between the interest on his investment and the gain to be realized by the lower temperature of the water. This may not always be an easy thing to do. Practice has shown that a pond should be between six and eight feet in depth to give good results.

Spray ponds may be made completely of concrete, although a cheaper method is to use as little concrete as possible and make the walls and bottom of puddled clay. The pond should be made to extend mostly below the surface, rising not more than one or two feet above. The exact location is usually determined by the head desired on the pumps. The sump, or collecting basin where the water is taken back, should be made of concrete and screened to prevent foreign matter from passing to the pumps and condensers. The concrete around the sump must be well bonded into the clay to prevent leakage around or under it. A spray pond placed well above the ground is a menace to surrounding property, because in case of failure a flood with its accompanying damages results. Provision should be made whereby the pond may be completely drained and cleaned. An overflow must also be provided sufficient in size to take care of the maximum amount of water which could ever reach the pond. In arriving at the size of the overflow, it must be remembered that the water is coming to the pond under some head and flowing from it through the overflow under practically no head, and that under these conditions a larger-sized pipe must be used for the overflow than is used to bring the hot water in.

Pumping Systems for Spray-Pond Service

Let us look now for a moment into the pumping-system side of the spray pond. The centrifugal pump is now almost universally used in this service. The reasons for this are its cheapness, good efficiency, flexibility and sureness of operation. It is simple in construction and therefore causes little trouble. Foreign matter will, to some extent at least, pass through it without injury to the pump, and there are no valves to get out of order.

There are some fundamental points to be observed in a centrifugal-pump installation. But one pump should ever be run on one suction. If two or more are made to use the same intake pipe, trouble will be experienced if it is desired to start one with the other running. The one that is running will tend to lose its suction. The same rule applies, although to a lesser degree, with the discharge pipe. Check valves may be employed to overcome this, but when at all possible each pump should have a separate discharge line. If the pump is placed above the level of the supply pond, provision must be made for priming the pump with a separate pipe from some other source. Frequently, the city water supply may be utilized for this purpose. When such conditions exist a foot valve must be placed in the suction line near the pump, otherwise the priming water would all run back to the well. It is usually good practice to place a gate valve in the suction line when the water comes to the pump under head. The pump is then accessible for repairs.

The Pump Should Not Be Placed Too High

When the pump is placed above the level of water in the well, care must be taken to see that it is not placed too high to give the best results. It is not possible to raise hot water by suction as far as it is cold water, owing to the evaporation of the water in the partial vacuum, which prevents the air pressure on the surface of the water in the pond from forcing water up to the pump. Most of the pump manufacturers furnish data from actual tests showing the amount of suction head possible for various temperatures of the water. This suction lift will also vary some with the altitude of the locality, and if very far above sea level this factor should be considered. At water temperatures above 160 deg. F. the pump must be fed under head. This is higher than usually met with in power-plant work.

It may be laid down as a good working principle to place the pumps low enough so that they may at least be filled by gravity when not running. This makes priming automatic, and with the gate valve closed on the discharge and the suction valve open, the pump is always primed and ready to start. Check valves should always be placed in the discharge line whenever the head worked against is large or when more than one pump discharges into one main. The check valve must be placed next to the pump and the gate valve beyond for two reasons: First, to prevent water-hammer from injuring the pump; and, second, to make the repair of the check possible without stopping the whole system. The suction pipe which extends into the water in the well must be well inserted to prevent a whirlpool action from drawing air into the suction line. If very much air enters in this way, the pump will lose its water and will have to be stopped and reprimed. This applies, of course, only in the case of pumps that are placed above the water level.

In concluding, the relative merits of spray ponds over the cooling towers might be enumerated:

1. They produce better and more uniform cooling.
2. They are cheaper in first cost and much cheaper to maintain.
3. Much lower head is required on the pumps, which represents a saving in power.
4. There is no air to handle or fans to get out of order.
5. Better control and more flexible is afforded.
6. They give a better supply of water for fire purposes.

The tower has one advantage of being available for use in close quarters.

Polyphase Watt-Hour Meters Connected on a Single-Phase Circuit

By E. A. FISCHER

For the registration of the energy consumed in two- or three-phase circuits, single-phase meters may be used or specially constructed meters may be employed. In Fig. 1 the two phases of the two-phase circuit are separate and therefore become two single-phase circuits; each watt-hour meter will register the power transmitted on its respective phase and the total power is the sum of the two individual readings, shown by each meter.

The two phases have a common return in Fig. 2, but the total power will be the same as in Fig. 1. In making the two-phase 3-wire connection care must be taken to see that the lead not passing through the meter is the neutral wire. By employing two single-phase watt-hour meters as shown in Figs. 1 and 2, it is possible to meter the energy in two- or three-phase circuits. However, in a three-phase circuit when the power factor is less than 0.5 one meter will reverse and the total power transmitted in the circuit is the difference of the reading of the two meters and not their sum. This method has the disadvantages that two meters take up more space and are more expensive than one meter and two readings must be taken, with the possibility of error in reading the meters. The readings of a 3-phase circuit would have to be added algebraically which further would tend to allow a chance of error to be introduced. Therefore it is preferable to use a polyphase meter in which one set of dials gives the true power consumption.

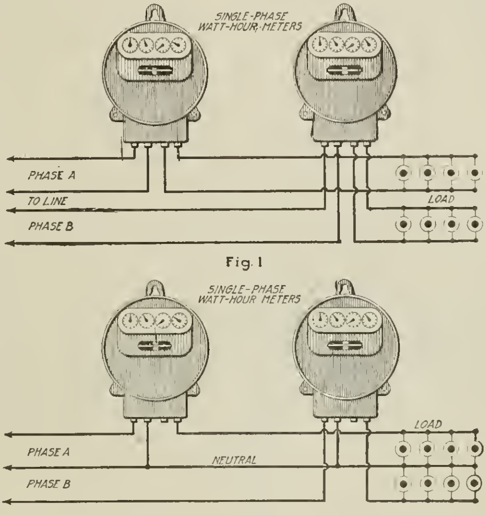

Fig. 1

Fig. 2

FIGS. 1 AND 2. SINGLE-PHASE WATT-HOUR METERS CONNECTED ON A POLYPHASE SYSTEM

Polyphase watt-hour meters can be tested and also be employed on a single-phase two-wire circuit. Fig. 3 shows the connections for testing 2- or 3-phase 3-wire meters on a single-phase circuit. In the figure the switch *S* can be thrown so that either of the series coils is put into the circuit and each element is tested separately, but the full-load speed of one element (either upper or lower) should be half the normal full-load speed of the meter. It is important, however, that both shunt circuits are connected during all tests.

If two- and three-phase three-wire meters and two-phase four-wire meters are tested on a single-phase circuit, the current coils of the two elements should be connected in series and the two potential coils connected in parallel, and divide the calibrating constant by 2. For three-phase four-wire meters employing three coils connect all three current coils in series and divide the calibrating constant by four. In connecting a polyphase watt-hour meter in such a way as to operate as a single-phase meter, it should be remembered, that if the two series elements are connected in series with each other, the current must pass through each coil in the same direction so as to produce rotation (see Fig. 4). If connected as shown in Fig. 5 the two elements will buck each other and will result in no effective turning effort, provided the meter has been properly balanced. In using a polyphase watt-hour meter as a single-phase meter, connected as in Fig. 4, the indications will have to be divided by 2 to obtain the correct reading. The speed of the meter will decrease to about half the normal full-load speed, if only one of the two elements is employed, and would vary according to the energy consumed, consequently the meter will be direct reading. However, the use of one current and one potential coil might introduce an error if the meter elements were not balanced perfectly—that is, each set of windings develop one-half the torque on balanced load—therefore it is better practice to have the upper and lower elements combined.

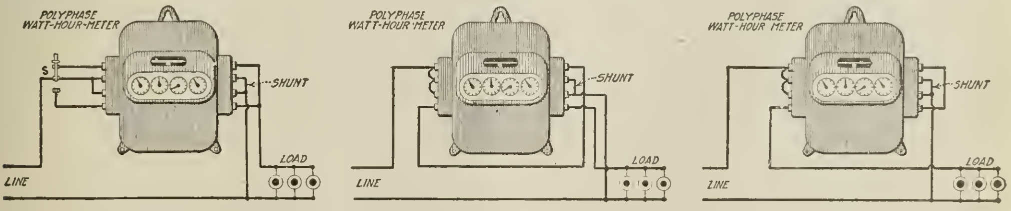
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Fig. 3 Fig. 4 Fig. 5

FIGS. 3 TO 5. POLYPHASE WATT-HOUR METER CONNECTED ON A SINGLE-PHASE CIRCUIT

How Efficiency and System in a Power Plant Brought Its Chief a Better Job

BY CHARLES L. BRUFF

JIM HARRIS was young and ambitious enough to tackle any kind of a job, but he could not help feeling the responsibilities of the one that had just been given him. That morning the "old man" had called him into the front office and told him his old "chief" could never be well again and that he was to have the job if he proved able to handle it. Jim knew he could do this for he had been keeping things running in good shape while the chief had been away. But he was not satisfied with this; he wanted to make a record and believed it could be done by cutting down costs in the plant.

Jim had for some time been planning in a general way what could and should be done to improve things, but now that it was "up to him" he was not quite sure of the best way to go about it. The new job had not swelled his head and he was not above asking for advice and taking it if he felt it was good and given in the right spirit. He had an old friend, Jack Walters, who had been through about the same mill a few years before, and who, he believed, could help him out with some good pointers. He had not seen his friend for some time as he had moved to another town, but he heard that Jack was more than making good and was on the road to the top with his company. In fact, Jack had always made good in every job he had held, and it had always puzzled Jim to account for his quick rise. They had gone to school together and began work about the same time, but Jack got his license first and a few years later was made chief of his plant. From this he had jumped to assistant superintendent of the factory and just a few months ago had been made superintendent of a new factory that had been built by the same concern. Jack had never been a special star at school nor had he shown any great mechanical talent, and as he had no "pull" his rapid climb up the ladder was hard to account for.

Jim decided to write his friend about the new job and ask for advice. He told Jack just how things stood in the plant: That the former chief had been a good fellow but not up to date, especially on power-economy methods, and that the factory manager seemed to care very little about what the fuel bills were as long as things ran all right, though a lot of money could be saved if he could be made to realize it and would stand for a small amount of expense for repairs and changes and for the instruments needed to find out exactly where the waste was taking place and what to do to stop it.

Jack's reply came promptly and started off by congratulating Jim on his promotion and wishing him success in his work.

"I appreciate your asking my advice," Jack wrote, "and whileI don't claim to be any shining example, perhaps I can give you a few tips that will help, for I have been through just what you are getting up against, and the methods I used seem to have worked out all right in my case and should in yours. Probably I can help you best in getting started along the right path by telling you my own story and how I went about saving money for the company by improving my plant. And that saving of money is just what started me going up to where I am today, because what any live concern wants in executive positions is not only a hustling producer—he has got to be that—but one that can produce at the lowest possible cost as well. It is true that savings in the power plant in fuel and materials take longer to show than savings in manufacturing departments, but if they are really there they are bound to show up and usually come out strong. I can see you have the right idea, that you have studied and are up to date in power-economy matters, so I won't go into details as to what I did in the plant, but will just give you the general plan on which I worked, reciting a few special cases to make things clear to you.

"My 'boss' did not know much about power plants, but he had a fairly good mechanical head. He surely was a business man and knew the value of a dollar as well as any man I ever saw. At the time he told me I was appointed chief engineer he gave me a good stiff talk, and some of the things he said certainly hit the mark. I have never forgotten them. He said he felt safe in turning the plant over to me because I had proved to his satisfaction that I knew my work and could be depended on. As long as I could keep things running right and keep the plant costs down where they were, the job was mine, but was I going to be satisfied with being an operating engineer all my life? You can bet I told him no, and that I expected to work myself up as far as my abilities would take me. Then he gave me one of the straightest tips I ever had in my life. 'It isn't all or even to a large extent a question of natural ability or of education that brings a man up the line' said he; 'it is the way he makes use of the ability and education he has. A man may have half a dozen university degrees and not be of half as much use in the business as the fellow with a high-school education and practical experience who has enough brains and common sense to put them to practical use. Remember one thing—in making your way in the world, it is not so much what you know that counts, but what you can let other people know that you know, in a way that will be of some value to them.

"'Take your case: You are young and ambitious and no doubt have a lot of ideas about improving your plant that you would like to try out. Soon you will be com-

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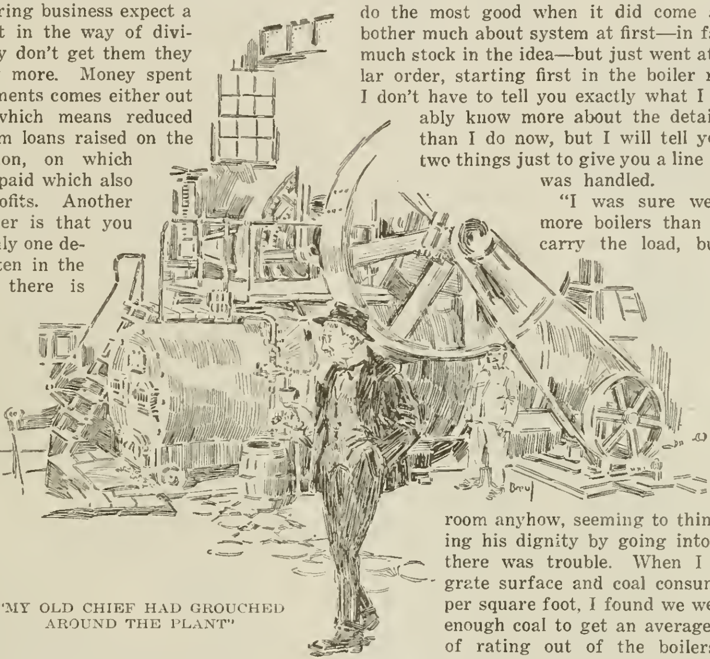
*Consulting Power Engineer, Philadelphia, Penn.

ing to me for money to buy new equipment and make changes with, and I hope you do. I will be disappointed in you if you don't, but when I turn you down on some of them, as I probably will unless your arguments are mighty good, don't get mad and nurse a grouch, for if you do you will be a quitter. Just tackle the job in some new way and come back at me again; that is, if you are sure you are right and it will be to the advantage of this concern to spend the money the way you suggest. You have got to look at my side of it as well as your own, so understand that the money that runs this business is not all mine to spend as I please, and if it were you can bet I wouldn't throw it away, anyhow. The people who put their good money into a manufacturing business expect a good return on it in the way of dividends, and if they don't get them they won't put in any more. Money spent on plant improvements comes either out of the profits, which means reduced dividends, or from loans raised on the concern's valuation, on which interest must be paid which also comes out of profits. Another thing to remember is that you are the head of only one department out of ten in the factory, and as there is only a limited amount of money that can be spent each year, I have to divide this up among the different departments so that it will be of the most benefit to the business as a whole.



"MY OLD CHIEF HAD GROUCHED AROUND THE PLANT"

"'Now you can see where the fellow that can tell me what he knows in such a clear, brief and businesslike way that he can convince me that he is right, comes in strong and can get things that the fellow who may know more but can't let me know it, can't get. First, be absolutely sure you are right, then work to convince me you are, and you stand a good chance of getting what you want if I can afford to let you have it. And don't forget that it isn't so much the number of hours a day you put in on the job that counts as it is what you accomplish during that time. You are now in an executive position in this organization, and the real executive, whether running a power plant or a million-dollar company, is the man who can lay out the proper amount and kind of work for the fellows under him and see that they do it and do it right. To do this you have got to have some sort of a system to work on, and it will pay you to study out a system for your plant and put it to work.'

"This talk from the 'old man' did me good and started me thinking along new lines. I remembered the times my old chief had grouched around the plant, cussing the boss and the company because he had been turned down on some pet scheme of his, and I began to wonder who was really to blame for our not getting the things we needed and if the chief had really put them up to the boss in the right way. He had certainly talked good common sense to me and seemed to be willing to do anything he could that was right for the plant, but it had to be proved to him that a thing was right before he would go ahead with it. After thinking it all over, I decided to see what could be done to improve the economy of the plant we had, by putting its equipment in the best possible shape and by getting the boys interested in economy work, before asking for any money for improvements. At the same time I figured I could be studying out how the money could be spent to do the most good when it did come along. I didn't bother much about system at first—in fact, did not take much stock in the idea—but just went at things in regular order, starting first in the boiler room, of course. I don't have to tell you exactly what I did. You probably know more about the details of this work than I do now, but I will tell you about one or two things just to give you a line on how the work was handled.

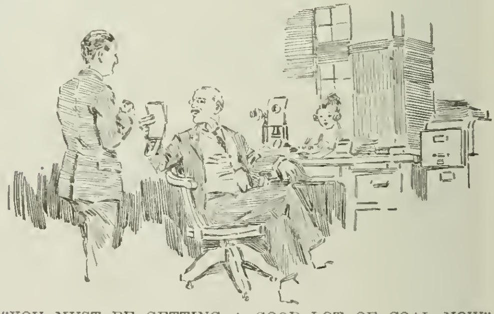
"I was sure we were running more boilers than were needed to carry the load, but the fireroom gang always balked on shutting one down, claiming they could not keep steam up without it, and the chief had backed them up. He never bothered much with the boiler room anyhow, seeming to think he was lowering his dignity by going into it except when there was trouble. When I figured up our grate surface and coal consumption per hour per square foot, I found we were burning only enough coal to get an average of 75 per cent. of rating out of the boilers and our load was very steady. I explained this to the gang and then started in to fix things so a boiler could be safely taken off. The settings and doors were leaking air, and these I soon got fixed up. After this was done, I found the damper regulator was shut about half the time, so one morning I had one of the fires banked. There was a kick, of course, but it took only a few hours' run to prove that the three boilers would carry the load as well as four and that their work was little if any harder in keeping up pressure. They had to pay more attention to keeping the fires in proper condition, which was what I was after, as with four boilers on it was a cinch to keep working pressure with any kind of firing. We were getting economical operation with no more actual work than there was when conditions were bad. I had a draft gage and flue-gas analyzer and went to work to get draft and fire conditions right, and when this was done the CO$_2$ jumped from about 6 per cent. to 10 per cent. and stayed there right along.

"I next went after the machinery, looking for steam leakage through valves and rings, and found plenty of it, though every unit was running like a clock so far as outside working parts were concerned. I had valves and rings fixed up, but did not go after any reboring or new parts, though some were needed. I went over throttle and drain valves for leakage and made them tight, and then tested out all the steam traps around the factory and had them put in good shape. Some steam and hot-water pipes were not covered, and this I had fixed up as well as possible with what stock we had on hand. I felt that about all that was possible had been done without asking for money, and the work had cost very little as it had all been handled by my own crowd. We burned about seven hundred tons of coal a month, and as the factory output stayed fairly uniform the coal bill had been started, the same each month for over a year. At the end of the first month after the patching up and combustion work had been started, the coal consumption dropped off about twenty tons. I said nothing about it, neither did the Boss, but I went after things harder than ever. At the end of the next month there was a further drop of thirty tons, and then he sent for me. 'You must be getting a good lot of coal now,' he said. 'I see you used only 650 tons last month and it used to run around 700.' I said it was good coal, but about the same we had been getting right along. 'Then how do you account for the coal figures?' he asked. 'The factory has been turning out just about the same amount of stuff as before.' Then I told him what had been done in the plant, and he grinned and said: 'I knew all the time what was going on, and you have the right idea. Keep after things, but don't forget what I said to you about putting a system to work.' He did not hand me any bouquets, but next pay day my envelope was quite some fatter than it had been before.

"I NEXT WENT AFTER THE MACHINERY"

"After a couple more months' running with the fuel bill staying about the same, as far as I could see we had done everything we could without spending money for outside help and new equipment, with which I was sure we could knock off at least another fifty tons a month, and it seemed about time to strike for what we needed. There were two ways of doing this: One was to give the boss a list of what I wanted all at once and tell him what it would cost, and the other was to put these things up to him one or two at a time. Remembering what he had said about having only a limited amount to spend at any one time, I decided on the latter course, though it meant delay in getting the savings I was after, and I picked out the most important things to go after first. Now I could go to him personally with these things and talk his ear off if he would listen, or I could get my figures down on paper and give him a brief estimate on the cost of a job or equipment wanted and an estimate on what it would save, and let him look it over and send for me if he wanted to talk about it. The latter method seemed to me the right one, and I tried it. I just gave him a safe figure on cost, a conservative estimate of savings and a brief statement of why and how the saving would be obtained, avoiding any windy arguments and technical stuff as far as possible. He seemed to like the method for I got a lot of things asked for, and most of them made good, because I had played pretty safe on my estimates. When a recommendation went in on paper, I knew it was a permanent record and would come up and kick me some day if my estimates were wrong or if what was bought did not turn out all right, so I was careful. The fuel bills kept on dropping and so did bills for oil, packing and other materials, and after a while the plant was running with a smaller force, though the fellows that stayed were making more money.

"You can imagine that doing all this inspecting, overhauling and fixing up, as well as regular routine work, kept me mighty busy. In fact, I put in from twelve to fourteen hours a day on the job during the first six months, and there did not seem to be much prospect of things easing up if we were to keep on getting economical results. I had no time for reading up on new things, hardly got a chance to even look over the engineering magazines I always subscribed for, and in spite of the time put in on the job there always seemed to be something that had been overlooked that would cause trouble. I liked the job, but was not satisfied to spend the rest of my life at it and could not see how to get any further along unless I could find more spare time for study. I used to wonder how it was the 'old man,' who had twenty times as much to think about and handle, could come down to the office at 8:30 every morning and leave before 5 at night, and yet manage to keep in touch with everything going on. Then I remembered what he had said about system in working, and it struck me that must be the answer, but I could not see how it would apply in my case. One day I spoke of this to our chief clerk, and he said right away that it was the answer and that system could be applied to any kind of work. I told him how hard it was to be sure of following up all the details of the power equipment in plant and factory, and he offered to show me how it could more easily be done.


"YOU MUST BE GETTING A GOOD LOT OF COAL NOW"

"You know what a 'tickler' card file is, don't you? Well, he gave me one of them, with a bunch of cards, and showed me how it was used by office executives in following up work. The cards were indexed so as to give a set for daily routine work, one card, or more if necessary, for each day of the week, filed under Monday, Tuesday, etc. Then there was a weekly set, indexed as first week, second week, etc., and then a set indexed under names of the months. There are certain jobs that should be done each day to keep things going right, and these are listed on the daily cards and checked off when you have seen them done or they are reported as done. The same cards are used for jobs done less frequently but on certain days of the week. The things done weekly or every second or third week are put down on the weekly cards and checked off when done. When all jobs on a card have been checked off as done, this card is moved back in the file to the next day or week that the jobs are again due on, and the same general method is used for following up monthly jobs or those to be done only once or twice a year at a certain time, using the monthly cards for these. If a job must be put off for any reason, its card is moved back to the next day, week or month, as the case may be, and taken up then. You can see what this system means to a busy engineer, after its details are once worked out and it is operating right, can't you? Instead of being worried all the time for fear he has overlooked something that may cause trouble or be wasting money, he knows at a glance just what has been taken care of, and what work has to be done for days, weeks and months ahead, barring, of course any breakdown or special repair jobs. He also has a permanent record of his work.

"I had to work out the details of the system for the plant, and it took some trying out before I got the jobs spread out over the right length of time, and coming on the right days or weeks; but it was not a hard matter to do this, and when it got working right it certainly took a load off my mind. I soon found that each day there would be certain regular jobs for each man in the gang and if any of them were tied up on special work it was not hard to shift these jobs to other men or put them off for a day, but the greatest thing about it was that nothing was overlooked and each man knew what he had to do and when to do it. I had to follow some of them up at first to see that they really did the work, especially on inspections, but after they found out I meant business there was very little trouble.

"NEXT PAY DAY MY ENVELOPE WAS QUITE SOME FATTER"

"After the system had been in use for several months, I began to find spare time on my hands during working hours. I could put in this time reading engineering magazines and technical books or in talking to salesmen, who often gave me a lot of good dope even outside the lines they were handling. I could also spend more time thinking out new ways of improving the plant and saving money and in putting these matters up to the boss in the best way. It was a surprise to me how this system of working, and especially the inspections, cut down our repair costs. We hardly ever had a breakdown; troubles were located and stopped before they got that bad.

"Well, Jim, that is about all there is to say. After the first year I found I could go home almost every night about the time the boss did, feeling quite easy in my mind, for I knew there was little chance of anything serious happening. I had my evenings free and took a course in factory management, and that, with the information picked up in going around through the works, gave me a fairly good knowledge of the business in general. Three years ago, when Brown, the assistant superintendent left, the boss gave me the job.

"I COULD GO HOME ALMOST EVERY NIGHT ABOUT THE TIME THE BOSS DID"

"If I were in your place, just taking hold of a power plant again, I would work about as outlined, but would go about it in a somewhat different way. If I knew the plant and the fellows in it well, as you do, I would first make them understand that we were out to cut expense for fuel and supplies by making better use of them, and try to make them see that it was to their advantage to do this, because a saving made in cost of materials would probably mean more money for those who effected it. Then I would fix up the plant as well as possible with the help of its own gang and start right away to work out a system of taking care of things, giving each man certain things to do at regular times and covering every detail that needed looking after, and then make it your business to see that they do the work assigned to them. It might be a good thing to ask your boss for the testing instruments you need, and if your arguments are strong enough you will probably get them. But if you do, make use of them; don't let them lie around on the shelf for ornaments or you won't get the other things you want. When you once get things in shape, it won't be long before the savings will begin to show up and then you can strike for money for improvements. Be sure, though, you know what you want and can prove its value, for one failure may do more harm than can be offset by several things that make good. You can't be a 'stand patter' if you want to get ahead, but you can't afford to be too enthusiastic and try to get money for anything that comes along that looks good."

Did Jim Harris follow his friends advice? He did. Did he make good? Well, if you knew his boss well enough to ask him who was next in line for promotion in his factory, he would tell you, Jim Harris.

The Absorption Refrigerating Machine—II

By H. J. MACINTIRE
Professor of Mechanical Engineering, University of Idaho

Tells the operating engineer those things he should know to operate successfully the absorption refrigerating machine.

PROPER conditions of operation are necessary to good results in the use of both the compression and the absorption machine. Too high a suction pressure will destroy useful refrigerating effect for the compressor; for the absorption machine, unless the generator distills off the ammonia properly and the absorber provides the necessary *stronger* aqua, the concentration of the aqua in the generator will not be maintained, and poor refrigeration will result. With the compression machine it is only necessary to operate with a proper suction pressure to get the desired refrigeration, but with the absorption machine the aqua must be of the proper average strength, the steam pressure must be high enough, the absorber must give aqua of high enough strength and the aqua pump must be operated at a desirable speed. This seems complicated, but it really is not so, as will appear in what follows.

Suppose we have a generator containing aqua of 26 per cent. (26 per cent. by weight of ammonia and 74 per cent. by weight of water) concentration. Suppose also that a condenser pressure of 161 lb. gage is carried (this is determined by the amount and temperature of the cooling water), such a solution at this temperature and condenser pressure will boil at 245.5 deg. F. This is similar to the action of heat on pure water. We say ordinarily that water in an open vessel will boil at 212 deg. F.; also that the temperature of the water (and steam) in a boiler at 125 lb. gage is 353.1 deg. F., and the temperature of steam under a vacuum of 26 in. is about 153.0 deg. F. In other words, when speaking of saturated steam, there is a definite, unvarying pressure for each particular temperature. This is also true for anhydrous ammonia, but aqua ammonia is different, because there is water present, varying in amount from 70 to 80 per cent. But if we have a certain concentration and a certain pressure, then the solution has a maximum concentration at a certain particular per cent. That means that at 26 per cent. under the pressure of 161 lb. and a temperature of 245.5 deg. F., there could not be any more ammonia dissolved. In other words, a saturated concentration at 26 per cent. and a condenser pressure of 161 lb. will have a temperature of 245.5 deg. But more important than this, if the pressure is 161 lb. and a temperature of 245.5 deg. F. is maintained, a concentration greater than 26 per cent. will cause some ammonia to be driven off as a gas. If the solution was 27 per cent. or 28 per cent. or 30 per cent., then while the temperature and pressure are maintained constant, a boiling action would continue until the remaining solution has a strength of 26 per cent. This is true of any solution of ammonia and water; that is, there is a certain fixed relationship of the pressure, the temperature and the saturation concentration, and if any two are known, the third may be found, as will be seen from the table.

TABLE I. TEMPERATURES, PRESSURES AND CONCENTRATIONS FOR AQUA AMMONIA

Pressure on Aqua in Pounds per Square Inch Absolute

*	10	15	20	25	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
2	169.0	189.4	206.5	220.0	231.1	249.4	264.3	277.9	288.8	299.0	307.8	316.2	323.7	330.7								
4	161.0	180.8	197.5	210.5	221.9	240.3	255.0	267.7	278.9	288.6	297.3	305.6	313.4	320.3								
6	153.0	172.3	188.8	201.5	212.4	229.5	244.0	258.0	169.0	278.5	287.4	295.3	302.6	309.6	316.0	322.2						
8	143.5	164.2	180.1	193.1	203.7	221.4	236.0	248.2	259.0	268.5	277.3	285.1	292.5	299.6	305.8	311.6						
10	137.4	154.3	171.1	183.7	194.6	212.3	227.0	239.6	250.5	259.5	267.9	275.8	282.9	289.4	295.7	301.8	307.4	312.6				
12	129.0	147.8	163.1	175.1	185.5	203.3	217.2	229.2	240.0	249.4	258.1	265.6	272.7	279.7	285.6	291.5	297.0	302.2				
14	120.5	140.1	155.5	167.4	177.6	195.2	209.1	220.8	231.2	240.5	248.9	256.1	263.0	269.7	276.0	281.8	287.3	292.4	297.1	302.0		
16	113.0	133.0	147.4	159.3	169.4	187.1	200.5	212.0	222.3	231.6	239.9	247.3	254.0	260.4	266.4	272.2	277.5	282.8	287.3	292.0		
18	107.5	124.9	139.4	151.4	161.2	178.3	192.0	203.1	213.5	222.6	230.9	238.0	244.7	251.0	257.0	262.5	268.0	273.0	277.6	282.4	287.0	291.7
20	99.0	117.3	132.0	143.6	153.8	170.2	183.6	195.4	205.0	213.8	221.8	229.1	235.9	242.0	247.9	253.5	258.6	263.6	268.4	273.3	278.0	282.7
22	92.0	109.9	124.6	139.9	146.0	162.7	175.9	187.0	196.9	205.6	213.5	220.6	227.1	233.4	239.3	244.7	250.0	254.9	259.3	263.9	268.5	273.0
24	86.0	103.0	117.0	129.5	139.2	155.2	168.7	180.0	190.0	198.4	206.0	213.0	219.2	225.5	231.3	236.7	241.9	246.7	251.0	255.5	260.0	264.5
26	79.2	96.3	110.6	122.1	131.9	148.2	161.0	172.1	182.0	190.7	198.2	205.1	211.5	217.6	223.4	228.7	233.7	238.4	243.0	247.2	251.5	255.8
28	73.4	90.6	103.6	115.3	125.0	140.6	154.0	165.2	174.7	182.8	190.3	197.1	203.1	209.3	215.0	220.4	225.5	230.3	234.5	238.9	243.2	247.5
30	66.5	83.8	97.0	108.5	117.8	133.5	146.1	157.0	166.4	174.9	182.7	189.4	195.6	201.3	206.9	212.2	217.3	222.0	226.7	231.1	235.1	239.3
32	61.0	76.9	90.0	101.0	111.0	127.1	139.4	149.7	158.8	167.3	175.0	182.0	188.2	194.0	198.4	204.5	209.4	213.8	217.7	222.0	226.4	230.8
34	55.0	71.6	84.0	94.8	104.5	120.0	132.0	142.4	151.9	160.2	167.8	174.6	180.9	186.6	191.9	197.0	201.7	206.1	210.0	214.2	218.3	322.5
36	49.0	65.5	78.5	88.8	98.1	113.5	125.8	136.0	145.3	153.3	160.7	167.3	173.5	179.3	184.7	189.7	194.5	199.1	202.9	206.8	210.6	214.4
38	43.0	60.0	72.5	83.2	91.8	106.8	119.4	130.0	138.7	146.7	153.8	160.3	166.4	172.2	177.5	182.5	187.3	191.7	195.6	199.3	203.0	206.9
40	37.0	53.8	66.0	77.3	86.0	101.0	112.9	123.4	132.3	140.0	147.0	153.4	159.4	165.0	170.5	175.5	180.1	184.6	188.9	192.8	196.5	200.1
42	31.6	48.7	61.0	71.5	79.4	94.0	106.3	116.4	124.9	132.5	139.8	146.4	152.7	158.2	163.5	168.5	173.3	177.7	181.4	185.3	189.2	193.0
44	27.5	43.2	55.3	65.3	73.6	87.8	100.1	110.3	118.8	126.3	133.4	139.9	146.0	151.5	156.7	161.6	166.3	170.8	174.3	178.2	182.0	185.0
46	21.2	37.6	49.7	59.6	68.1	82.0	94.0	104.2	112.8	120.1	126.9	133.4	139.5	145.0	150.2	155.0	159.4	163.8	167.5	171.3	175.2	179.9
48	16.0	32.0	44.4	54.2	62.7	76.7	88.3	98.5	106.7	114.0	120.6	127.0	132.9	138.4	143.7	148.6	153.3	157.5	161.2	164.9	168.6	172.5
50	11.0	26.8	38.9	48.4	56.8	70.9	82.6	92.6	100.8	108.3	114.9	121.0	126.9	132.4	137.2	142.0	146.4	150.7	154.9	158.7	162.4	166.0

* Concentrations

Such being the theory of the action of the generator, let us see how the action is accomplished. In the generator steam coils are provided, so arranged as to supply the heating surface necessary to drive off the ammonia gas and steam. This is somewhat similar in manner to the case of a steam boiler. In a water-tube boiler we usually say that 10 sq.ft. of heating surface is required per boiler horsepower. In the generator 14 or 15 or 16 sq.ft. of heating surface is used per ton of refrigeration. Of course in the generator we could use very hot steam in the heating coils—say steam at 75 lb. or 100 lb. pressure—and in consequence of such intense heat (comparatively) the heating surface could be cut down to 12 or 10 or even to 8 sq.ft. Nowadays, however, the demand is only for low-pressure (exhaust) steam absorption machines. In the case cited it might be desirable to boil the solution down to 22 per cent. (requiring a temperature of the aqua of 262.1 deg. F.), and as a mean concentration of 26 per cent. would be used, then 30 per cent. concentration could be looked for in the strong aqua. The steam pressure must be such as to give a sufficient temperature difference between the steam in the coils and the aqua. For example, 262.1 + 10 deg. = 272.1; that is, a 28-lb. steam pressure is required.

The action then of the generator is to boil off a vapor which is a slightly superheated ammonia. This is obtained by having a temperature sufficiently great in the steam coils, determined by means of the values given in the table. Increasing the steam pressure or decreasing the head pressure or increasing the concentration will stimulate the boiling action, but the easiest means of control in the hands of the operator is the steam pressure. If capacity is not being obtained, a rise of steam pressure will give hotter steam, therefore a greater temperature difference and a greater heat transfer. The result will be that more steam will be condensed in the coils and more ammonia gas will be distilled out of the generator.

It is readily seen from the foregoing that one of two things in the generator may be wrong if the plant is found not to condense the ammonia properly—either there is too weak a concentration in the generator or the steam pressure is too low. In either case charging more anhydrous into the system or increasing the steam pressure will give the same results; namely, having enough difference between the condensing temperature of the steam and the boiling temperature of the aqua to enable sufficient heat to pass through the heating surface of the steam coils. All of this may be seen from the table. For instance, suppose it is found that ammonia is not being condensed fast enough in the condenser, though the latter is working properly and the rectifier is not cooling the gas too much. Suppose the steam temperature is 250 deg. F. and the condenser pressure is 161 lb. It is possible to take a sample of the weak aqua and test it for its concentration. This, however, is not really necessary if we have a means of measuring the temperature of the aqua as it leaves the bottom of the generator. Suppose the temperature is 245 deg. F. Referring to the table, the concentration is found to be only 26 per cent. If this concentration had been 28, then it is evident that boiling of the ammonia would have occurred at a lower temperature (237.1 deg. F.), more pounds of ammonia would have been evaporated. The same result necessarily would have occurred with an increase of steam pressure.

TABLE II. POUNDS OF STRONG AQUA REQUIRED PER POUND OF AMMONIA EVAPORATED

Concentration Weak Aqua	Concentration—Strong Aqua 20%	22%	24%	26%	28%	30%	32%	34%
18%	41	20½	13⅔	10¼	8.2	6.84	5 86	5.12
20%	..	40	20	13⅓	10	8 0	6 77	5.71
22%	.	.	39	19⅓	13	8.75	7 8	6.5
24%	.	...	. .	38	19	12⅓	9⅓	7⅗
26%	.	...	.	...	37	18⅓	13⅓	9.25
28%	.	...	.	...	....	36	18	13.0

The action of the absorber is somewhat like that of the jet condenser, and reference to a few of these similarities may make the subject clearer. In a steam condenser the vacuum (or back pressure on the turbine) is produced by condensing the vapor. The total pressure exerted is the sum of the vapor (steam) pressure and the air pressure. This air pressure accumulates and has to be removed by means of an air pump, or the vacuum would be lost. In a similar manner the back pressure or boiling pressure of the ammonia in the brine cooler on the expansion piping is determined by the action in the absorber. The slightly superheated gas from the expansion coils passes into the absorber and is allowed to come in contact with a spray of weak cold aqua, or is allowed to bubble up in the aqua. Since the aqua is not pumped away as the water is in the jet condenser, the heat of condensation and of solution has to be taken away by an outside medium, which in this case is the cooling water used. But, as in the case of the surface or jet condenser, the total pressure in the absorber is equal to the pressure due to the vapor tension plus that due to air or inert gases present.

The vapor tension in the absorber is determined by the temperature and concentration of the strong aqua in a manner similar to that used in the case of the generator. For example, if the strong aqua is 90 deg. F. and 32 per cent. aqua is being carried, then the vapor tension is (from the tables) 20 lb. abs., or 5 lb. gage. But this 5 lb. gage is possible only when the absorber is purged out. A new plant is likely to have a large amount of air in the system, and this will slowly accumulate in the absorber. If air collects, which will itself exert a pressure of 3 lb. per sq.in., then the total pressure in the absorber will be 8 lb. The pressure at which boiling of the ammonia takes place is not the absorber pressure. It tends to become this pressure, but in fact there is usually considerable "wiredrawing" between the two pieces of apparatus, and the result is that the pressures of the brine cooler or expansion headers are usually from two to five lb. in excess of the absorber pressure. This last loss of pressure may be eliminated by making the pipe-line connections and gas headers of liberal size. The inert gas may be removed in a manner similar to that used in the ammonia condenser.

Effect of Temperature of Cooling Water on Operation of the Plant

Reference to the table also shows the effect of the temperature of the cooling water on the operation of the plant. For instance, the absorption machine finds its particular sphere of action in low-temperature work. A strong aqua of 32 per cent. concentration and at 5 lb. gage must be cooled at least as low as 90 deg. F. If the temperature of the water rises so that the aqua is kept at 97 deg. F., then the aqua concentration (see table) will be 30 per cent. instead of 32. Usually, the absorption machine operates under small differences of concentration, like 22 per cent. to 26 per cent. If the machine had been designed for operation between 26 and 32 per cent. and the aqua fell in concentration to 30 per cent., the aqua pump would have to be speeded up and the steam economy in the generator (as well as the economy of water used in the absorber) would be decreased.

The reason for the last statement may be seen on examining the action of the strong-aqua pump. This pump has a function similar to the boiler-feed pump which takes the feed from an open feed-water heater. But the strong aqua is only a carrier—a pound of strong aqua has a little (sometimes a very little) more ammonia absorbed in it than does the weak aqua entering the absorber. This strong aqua carries back to the generator the ammonia absorbed in the absorber. Therefore, if it takes 12⅓ lb. of strong aqua to carry back one pound of ammonia, a drop in concentration from 32 to 30 per cent. would necessitate pumping 18⅔ lb. of aqua, or one-half more than before. So, evidently, it is important to keep the strong aqua as strong as possible, and for satisfactory operation of the plant a means of getting the strong-aqua temperature as it leaves the absorber should be provided. If no inert gases are present, then the concentration may be obtained from the aqua tables corresponding to the temperature and pressure. The effect of the concentration on the action of the pump may be seen from Table II.

The Difference in Concentration Should be Kept as Great as Possible

Generally speaking, it is wise to keep the difference in the concentration as great as posssible. The reason for this is that the weak aqua has to be cooled by cooling water before admitting it to the absorber, and also the strong aqua has to be returned to the generator at a temperature much below the temperature of the aqua there. This latter action is as bad for economy as is the pumping of cold water into a steam boiler. For before the ammonia can be distilled, the aqua must be heated up to the temperature of the solution in the still. If a very little aqua is circulated (large differences of aqua concentrations being used) then this loss is small, but if a large amount of aqua is pumped the loss is appreciable and should be corrected.

In conclusion, it is recommended that the operating engineer operate the absorption machine by reference to a table on the properties of aqua ammonia. If he is equipped with suitable means for securing the necessary temperatures, the concentrations are easily found. If thermometer wells are not provided, he can improvise a substitute by making a "pocket" for oil on the outside of the pipe, into which the thermometer may be placed for approximate temperature determinations. He should remember that the absorber gage and the condenser gage show the total pressure, but that the ammonia pressure is a "partial" pressure less than that shown. Finally, he must remember that the concentration must be maintained and the pump action must be satisfactory to get desirable operation.

Flywheel Effects of Synchronous Motors

By W. T. Berkshire*

Synchronous motors driving air or ammonia compressors or other reciprocating apparatus embody, in the most essential respects, the same factors as engine-driven generators, so far as synchronous operation is concerned. Whether a synchronous machine is operating as a generator or as a motor, it behaves in the same manner as regards stability. That is, if its rotor is pushed or pulled away from the stable position in rotation—whether this be at no load or full load—there is a force opposing such displacement that is practically proportional to the displacement. Hence, if a variable torque is imposed upon the shaft, either positive or negative, that is, either generator or motor operation, there will exist the tendency toward instability.

An air or ammonia compressor is a reciprocating machine of relatively large mass, and therefore has a turning-effort curve which in a general way resembles that of reciprocating engines. The variations are periodic and of sufficient magnitude to cause the motor to oscillate if proper precautions are not taken. The precautions consist in the use of flywheel weight sufficient to limit the periodic angular deviation to 3.5 electrical degrees in either direction from the position of uniform rotation, and to fix the natural oscillating frequency at a safe distance from the frequency of the forced impulses of the compressor. The two most important impulses have frequencies equal to the revolutions and to the strokes of the compressor, and it is considered desirable to keep the natural frequency of the motor away from the revolutions or strokes by 20 per cent.

For any given unit the natural oscillating frequency of the rotor can be changed by changing the flywheel effect, as shown by the relation,

$$F = \frac{35{,}200}{S} \sqrt{\frac{P_o \times f}{WR^2}}$$

where

F = Natural oscillating frequency in beats per minute;

S = Revolutions per minute of motor (direct connected);

f = Motor frequency in cycles per second;

WR^2 = Total flywheel effect in 1 lb. ft.^{2} (rotor and flywheel);

P_o = A factor depending upon the synchronizing force of the motor.

This formula may be used as a guide to avoiding values of flywheel effect which, on account of resonance, or near resonance, of the natural oscillating frequency with the forced compressor impulses, would likely result in serious hunting trouble. The formula does not give the WR^2 necessary to limit the periodic displacement to 3.5 electrical degrees. This can be determined only from data that the compressor builder has at his disposal.

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Preventing a Roll of Tape from Unwinding

By B. A. Briggs

A roll of linen tape is something that must be handled with care when taping a coil, for if it is let fall it will probably result in a tangle. One method of, to a degree, preventing the roll from unwinding so easily is to paint on both sides two stripes about one inch wide with shellac or paint, at right angles to each other, as in Fig. 1. This, however, leaves hard spots on the edges of the tape.

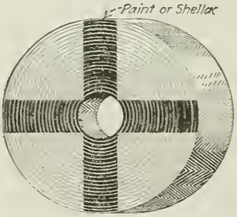


FIG. 1. PAINT OR SHELLAC STRIPS ON ROLL OF TAPE

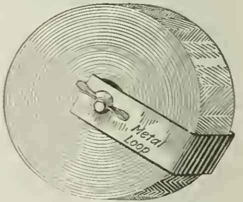


FIG. 2. METAL LOOP IN PLACE ON ROLL OF TAPE

Another method and one that does prevent unrolling of the tape except under tension is shown in Fig. 2. This consists of a loop made of thin spring steel bent so that the ends can be held at the center of the roll by a bolt. The necessary amount of pressure on the roll to prevent it from unwinding except when the tape is under tension is obtained by tightening the wing-nut until the desired result is obtained.

Economical Repairing of Starting Boxes

By E. C. PARHAM

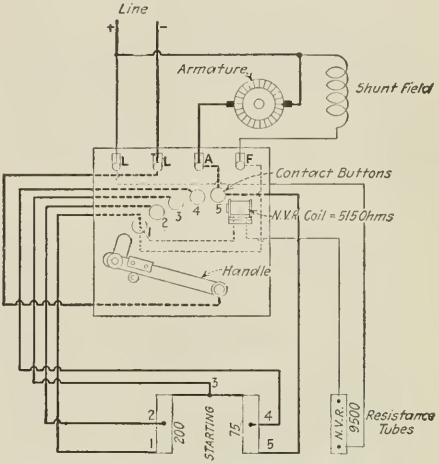
Methods are given for obtaining and keeping records to enable the repairman to intelligently make repairs on starting rheostats. The results of wrong connections are also discussed.

IN MAINTAINING a large number of starting rheostats of different types, makes and dates of manufacture, the more correct information available in regard to their various parts the more promptly and economically will it be possible to make the repairs and return them to service. Nearly all manufacturers have a general construction scheme running through a certain line of starters, and acquaintance with this scheme may mean the repairing of a starter from the hopeless remains of others of perhaps entirely different ratings. For example, several sizes of starter may include resistance tubes of the same rating, but which may be grouped in different combinations of series and parallel connections. On starters, the no-voltage release coil of which is connected in series with an independent resistance tube, frequently will it be found that the no-voltage coils and their resistance tubes are interchangeable on several sizes of starters of the same voltage. However, similarity of appearance and dimensions of these parts is by no means an indication that they may be used one for the other—their electrical characteristics may be widely different. On starters, the no-voltage release coil of which is intended to be connected in series with the shunt-field winding of the motor, the no-voltage release coil must be wound with wire that is able to safely carry the shunt-field current, the values of which differ widely on motors of different sizes. Owing to their being wound with wires of different characteristics, resistance tubes that appear to be the same may be entirely unlike as regards resistance values and current-carrying capacity. Very little can be assumed as to appearance where the resistance wire is embedded in cement or in enamel.

Not infreqently chances are taken in the emergency repairing of starting boxes, and in many cases these chances are temporarily a profitable investment; but such practice should be the exception. In order to make the repairs intelligently without depending upon the manufacturer, measurements of resistance must be made and coil groupings checked and records kept; otherwise the repairman will frequently find himself at a disadvantage.

Fig. 1 shows the information desirable to keep in card form for each starter that is sent in for repair. The manner of getting the information is as follows: The panel is lifted from the box without disturbing the connections. Then beginning with the active button nearest to the "Off" position, tag the tap that is connected to that button, No. 1, each succeeding tap toward the "Full-On" position being tagged with the next higher number. This tagging before disconnecting is absolutely essential, if confusion is to be avoided, because the taps are not always brought out of the resistance in the order in which they are connected to the buttons, and the coil arrangement on some starters is much more complicated than that shown in Fig. 1.

Having tagged the taps, the battery of resistance tubes may be removed for inspection and for resistance measurement with a Wheatstone bridge or some other method. The first resistance section is included between taps 1 and 2; the second between taps 2 and 3 and so on; the first column of Fig. 1 designating the sections. Next measure the resistance included between taps 1 and 2, 2 and 3, etc., until all sections have been measured, in each case putting the resistance value opposite the section to which it belongs, as indicated in the second column of the figure. Finally measure the resistance between taps 1 and 5; this resistance value should equal the sum of the resistance of the individual sections. In no case should the resistance of any section exceed that of the section nearer the "Off" position.



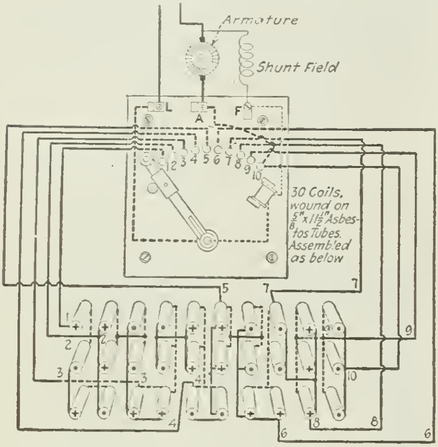
SECTION	RESISTANCE	NO. TUBES	RESISTANCE PER TUBE		MFGS. MARK
R1-R2	105	½	205		200A
R2-R3	100	½			
R3-R4	38	½	75		75-A
R4-R5	37	½			
R1-R5	280	2			
NVR Res.	9500	1	9500		9500
MANUFACTURER		SERIAL NO.	SIZE	TYPE	VOLTS

FIG. 1. CONNECTION AND RECORD SHEET FOR SMALL-SIZE STARTER

In column 3 is given the number of tubes or, in this case, the fractional part of a tube in each section. In starters of greater capacities, as will be indicated later, some sections will include whole tubes in series; other sections will include combinations of tubes in parallel. In column 5 is found the markings used by the manufacturer; such markings are used in ordering new tubes.

In event of the interior of the box being so badly burned as to destroy the identity of coils and taps, the only thing to do is to order an entirely new set of coils from the manufacturer, from which standard information can be obtained. Such of the old coils as are worth saving should be suitably marked and stored for making future repairs. Should measuring of the section resistance disclose confusion of taps—a condition that easily may account for the failure of the starter—the taps and tagging should be investigated as follows:

Calling the end nearest the "Off" position tap No. 1, separate the coils, if necessary, so that the circuit through the resistance to the last tap can be traced by eye. Then beginning at No. 1 end and in consecutive order mark the intermediate taps No. 2, 3, etc. to the highest number, which in this casė will be No. 5. On some starters the No. 1 end may be easily identified by the fact that only series tubes will be included in the first resistance section, while those sections near the "Full-On" position will include series parallel or parallel combinations of tubes. The sections of higher resistance always should lie at the No. 1 end of the assembly. The investigation of the taps may show that the tags have been wrongly placed, in which event they should be changed and all section resistance again measured and recorded. As a final check the resistance from tap No. 1 to each of the other taps should increase in the order of the numbers.


Armature
Shunt Field
L
A
F
1
2
3
4
5
6
7
8
9
10
30 Coils, wound on $\frac{5}{8}$"x$1\frac{1}{2}$" Asbestos Tubes. Assembled as below
5
7
7
9
10
1
2
3
3
4
4
6
8
8
6

SECTION	NO. TUBES	CONNECTION	RESISTANCE	RESISTANCE PER TUBE
1-2	4	Series	7.80	1.95
2-3	6	3Se. x 2 Par	4.85	3.23
3-4	4	2 " x 2 "	3.30	330
4-5	4	2 " x 2 "	3.30	3.30
5-6	2	2 Parallel	1.70	3.40
6-7	2	2 "	1.00	2.00
7-8	2	2 "	0.95	1.90
8-9	3	3 "	0.74	2.22
9-10	3	3 "	0.66	1.98
1-10	30	30 Ser-Par.	24.30	

MANUFACTURER	SERIAL NO.	SIZE	TYPE	VOLTS

FIG. 2. CONNECTIONS AND RECORD SHEET FOR MEDIUM-SIZE STARTER

Fig. 2 gives full information in regard to a 10-hp. starter composed of 30 resistance coils wound on asbestos tubes and having 10 taps. Assuming current to enter the resistance on tap No. 1 and to leave on tap No. 10, it will be noted that in passing from tap No. 1 to tap No. 2, 4 tubes are in series; from taps No. 2 to No. 3, two parallel paths of 3 tubes in series are passed through; from No. 3 to 4, two parallel paths of 2 tubes in series; from No. 4 to 5, the same as from 3 to 4; from No. 5 to 6, 6 to 7, and 7 to 8, 2 tubes in parallel. The tubes included between 5 and 6, however, being different from those included from 6 to 8, as indicated by the different values of resistance as recorded in columns 4 and 5 of the table. From taps 8 to 9 and from 9 to 10, three tubes are in parallel, but these are of two different kinds as indicated by the fact that the tubes of sections 8 to 9 measure 2.22 ohms each, and those of section 9 to 10, 1.98 ohms each. These measurements were taken from a box that had been in use for several years and which had been sent in on account of the no-voltage release coil having been burnt out as the result of a ground in the motor's field coils.

I have never experienced any trouble with either the tap-tagging or the coil assembling of resistances received from the manufacturer and have had to do with hundreds of starters. However, the interchanging of taps and the installing of coil assemblies end for end in the containing cases appear to be characteristic of starters that have been repaired a number of times by miscellaneous workmen unacquainted with the exacting conditions of the work. Once an error in tagging or connecting is made, it is likely to be repeated whenever the starter is repaired, unless systematic measurements are taken to prevent it.

Assuming for example that the assembly is correct and that all taps have been brought out in consecutive order, if the assembled tubes as a whole are installed end for end in the case, thereby bringing tap No. 1 over to the "Full-On" side of the panel, the operator is apt to connect the first tap to the last button and the last tap to the first button, the intermediate taps being connected consecutively but in reversed order. Such a connection will start the motor on the first button with the usual impulse, because the total amount of resistance on the first position will be the same as if the coils were correctly connected, the current entering the last tap and leaving by way of the first, thereby including the whole resistance. But on subsequent taps the resistance will be cut out in increasing increments instead of in decreasing ones. Therefore no speed increase may be noticed on the first few positions of the starting handle. As the handle approaches the "Full-On" position the resistance will be cut out in large units, causing the speed to accelerate in impulses that may result in the throwing off the belt and cause the brushes to spark to a degree depending on the connected load and on the size and design of the motor. Such a condition may persist for months if the operator is not particular as to how a machine should behave and the connected load is light. If the load to be started is heavy, the resistance sections that are near the "Full-On" position are likely to burn out, because they are composed of conductors of comparatively small current-carrying capacity and remain longest in the circuit, when they should be cut out on the first positions of the starter handle. This can be seen from the tables of Figs. 1 and 2. In connection with the starter, Fig. 1, which has only 5 notches, 37 per cent. of the resistance is cut out on the second button. In connection with the 10-hp. starter, 32 per cent of the resistance is cut out on the second button.

Too much care cannot be taken in the matter of keeping such records as will enable a repairman to restore every starter to its original condition; not only is such precaution a vital factor in determining the useful life of the starter itself, but it is a vital factor in determining the life of the motor and in insuring the continuity of its operation.

The Boiler Blowoff

By CHARLES L. HUBBARD

Facts relating to boiler blowoff pipes and connections that every engineer and fireman should know. Practical suggestions regarding the installation of such piping, protection of same and how it handles the blowoff valves are given.

EXPERIENCED engineers have proper respect for the blowoff pipe and connections. Every engineer and fireman should bear in mind that the various boiler connections are under the same pressure and should be installed and handled with equal care. Although the actual number of defects in blowoff equipment may not be as great as those in connection with some other part of the boiler, a comparison of results compiled some time ago by the inspectors of a boiler-insurance company showed that a much greater proportion of defects of this kind were actually dangerous. For example, out of approximately 40,000 defects due to deposit of sediment, 20,000 were of incrustation and scale, and 4000 were of defective blowoffs, and practically the same number, 1200 of each kind, were listed as "dangerous." This same report shows that there were more than twice as many blowoffs in a dangerous condition as safety valves.

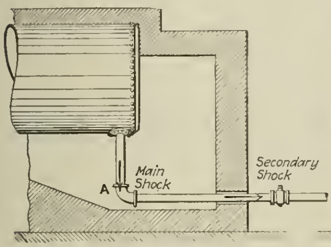


FIG. 1. SHOCK EXERTED ON ELBOW

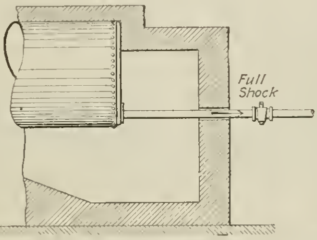


FIG. 2. SHOCK EXERTED ON VALVE OR COCK

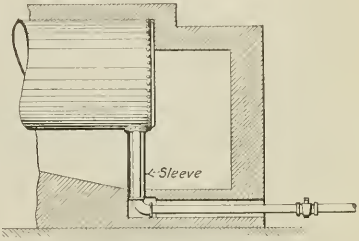


FIG. 3. FITTING PROTECTED FROM THE FIRE

The boiler blowoff is used for two purposes—that of emptying the boiler for washing out, inspection or repairs, and for blowing out a small amount of water at intervals for the removal of impurities which collect and for preventing the boiler water from becoming too concentrated.

When emptying, the pressure should not exceed three or four pounds and the brickwork should be allowed to cool somewhat before blowing down, so that the boiler will not reabsorb heat after it is empty; otherwise any mud or soft scale present will be likely to bake on the shell and be difficult to remove.

The impurities which should be blown out at intervals vary in character according to the quality of the feed water and its service. In some cases considerable fine sand or mud may be held in suspension, also vegetable or organic matter in various forms, part of which will settle when the water is at rest and the remainder will float in the form of a scum, especially when mixed with oil from returned condensation that has not been properly purified. Impurities of the latter form can be removed only by a surface blowoff or skimmer. Feed water frequently contains various salts of lime and magnesia as well as other mineral substances in solution. Some of these will be precipitated by heat before the temperature of evaporation is reached, and others will remain in solution until the water has passed the point of saturation, due to evaporation, after which they also will be precipitated as a hard coating upon the boiler plates.

Substances that are thrown down before the boiling point is reached may be removed before admitting to the boiler by means of purifiers or certain forms of feed-water heaters; organic matter may be disposed of to a considerable extent by filtration. Mineral substances, which are precipitated only from a solution that has passed the point of saturation, must be cared for by frequent blowing off and the admission of fresh water to prevent sufficient concentration to bring about this result.

When outside purification is not carried on, then the soft mud or sludge that is precipitated by heat must be disposed of before it has a chance to harden, and may be blown out with the water that is discharged to prevent concentration. Hence, the dangers resulting from deposit, incrustation and scale, internal corrosion and burned plates can often be prevented, or at least minimized, by an intelligent use of the blowoff.

A 100-hp. boiler will evaporate approximately 30 × 100 = 3000 lb. of water per hour, or 300 × 8 × 300 = 7,200,000 lb. per year, which is equal to about 900,000 gal. If each gallon of feed water contains 30 grains of dissolved mineral matter, which is a moderate amount, the total deposit of solid matter, provided the blowoff is not opened, will amount to 900,000 × 30 ÷ 7000 = 4000 lb., very nearly, or 2 tons.

Of course a boiler could not hold this amount without being practically destroyed by overheating, but boilers have been frequently inspected containing hundreds of pounds of deposit that had accumulated by neglect.

Every boiler should be blown down an inch or so at least once a day, and twice or three times when the water is bad and the boiler is operating at full capacity. The objection is sometimes raised that this causes too great a loss of heat and is, therefore, wasteful, but experience seems to prove that this practice is more than compensated for by the reduced cost of cleaning and also by the higher efficiency obtained, due to the more rapid transmission of heat through plates that are kept comparatively free of sediment and scale. Boilers should be blown down only after they have stood quietly for an hour or so in order that the sediment may have had an opportunity to settle. The best time for doing this may be in the morning, before starting up the fires, or just before 1 o'clock, after the boilers have been standing idle during the noon hour, or at night, some time after the plant has been shut down, the most convenient time varying somewhat under different conditions.

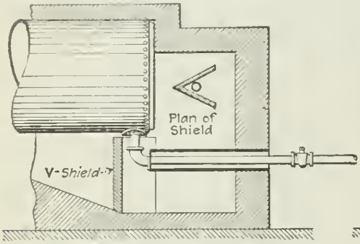


FIG. 4. ANOTHER METHOD OF PROTECTING BLOWOFF PIPE

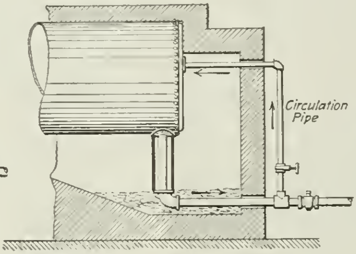


FIG. 5. ARRANGEMENT OF CIRCULATING PIPE

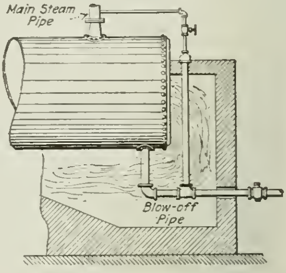


FIG. 6. BLOWOFF PIPE WITH STEAM CONNECTION

In any case the blowoff should always be opened before the fire has been touched in any way, for the circulation of the water in the boiler will be established to some extent as soon as the fires are brightened. The effect of this will be to pick up a certain amount of the sediment and whirl it about, so the proportion blown out will be much less. When a blowoff pipe is flushed, it is not enough to open the valve a little way. It should be opened wide, if only for a few seconds, because if this is not done the full boiler pressure will not be realized and the pipe may not be thoroughly cleared. The quantity of water blown out, when flushing the pipe, is not of so much importance as that the full area be uncovered so that a solid column of water may seep through and carry away any deposit that may have accumulated. This process, it should be understood, is independent to some extent of that of blowing down the boilers, although they are usually combined.

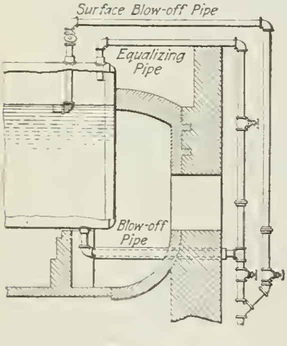


FIG. 7. BLOWOFF PIPE WITH STEAM CONNECTION

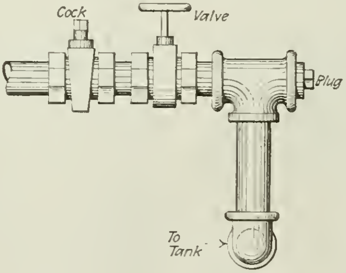


FIG. 8. PLUGGED TEE, USEFUL FOR DETECTING AND REMOVING SCALE

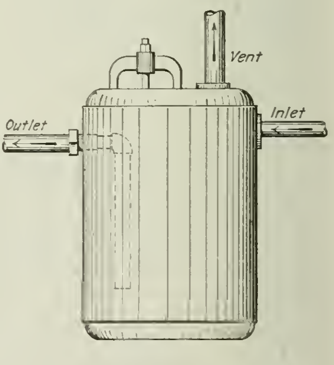


FIG. 9. BLOWOFF CONNECTION TO BLOWOFF TANK

Special attention is called to the proper method of opening and closing the blowoff valve. This should never be done suddenly, and for this reason a valve is better than a cock, because the former takes at least several seconds to open or close, but a cock may be quickly thrown from one position to another. It is not at all uncommon to see a fireman open a blowoff cock with a yank and close it with another. This practice is dangerous, and no valve about a steam system should ever be opened or closed suddenly, except perhaps in an unusual emergency, because sudden strains on a boiler or piping are much more destructive than those that come gradually. The enormous blow that may be struck with a solid slug of water, when its motion is suddenly stopped, can hardly be realized, especially when it is hidden from view; and a blowoff pipe discharging at a high velocity is as harmless in appearance as a heavily charged electric wire. However, both are capable of great damage if improperly managed.

It may be shown either mathematically or experimentally that stopping the flow of water instantly will increase the pressure, momentarily, about twenty times. Hence, when blowing down under 80 lb. pressure, an instant closing of the cock would raise the pressure to approximately 20 × 80 = 1600 lb. Of course, in practice, a valve or cock cannot be closed instantly, and the friction of the pipe also has some effect, but the foregoing gives an idea of the possible damage under ordinary working conditions.

It has been shown by computation that for a 3-in. blowoff pipe 5 ft. long, discharging under 80 lb. pressure, an instantaneous closing of the cock would cause a blow equal to over 2300 ft.-lb., or a force sufficient to raise a weight of one ton one foot in height. Of course, under actual conditions, there will be a certain amount of steam mixed with the water, which, with the friction of the pipe, will reduce the force of the blow somewhat. Neither can a fireman close the valve instantly, so the full force of the shock computed would not be realized. If this were not so, fatal accidents would be much more common than at present.

Blows of this kind are received by the pipe and fittings, which frequently rupture under the impact. A common point of fracture is at *A*, Fig. 1, where nearly the full force is taken by the elbow and a portion is passed on to the valve or cock. In Fig. 2 the full force of the shock is received by the latter. Sometimes threads are stripped instead of the fitting giving way, when the joint has not been properly made. As the force of the blow depends to a considerable extent upon the weight of the slug of water contained in the pipe, it is evident that the pipe should not be larger than necessary to carry off the sediment and scale without danger of clogging the pipe.

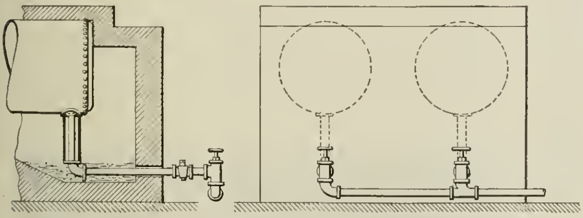


FIG. 10. TYPICAL ARRANGEMENT OF BLOWOFF PIPING CONNECTIONS

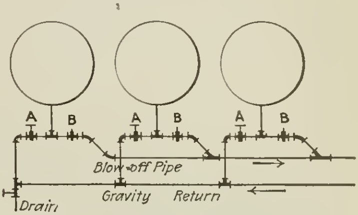


FIG. 11. BLOWOFF PIPING ARRANGED FOR LOW-PRESSURE RETURN

Insurance companies recommend $1\frac{1}{2}$ to $2\frac{1}{2}$ in. as the limiting diameters for all the ordinary conditions. The A. S. M. E. Boiler Code recommends a minimum size of pipe and fittings of 1 in. and a maximum size of $2\frac{1}{2}$ in. Globe valves are not to be used in such connections. The length of pipe also adds to the weight of water contained, and should be no greater than necessary to give the proper flexibility and to make it accessible for operation and repairs.

The method of making the blowoff connections will vary somewhat with local conditions, although there are certain general precautions to be observed. Two ways of bringing the pipe outside the setting, in case of a return-tubular boiler, are shown in Figs. 1 and 2. The latter has the advantage of having no fittings exposed to the fire within the setting, but it does not fully drain the boiler and therefore allows mud and sludge to remain on the bottom of the shell, where it is likely to bake into a hard scale and so produce burning or bagging of the plates. Fig. 1 gives much better drainage, and the elbow may be protected by carrying the horizontal portion below the paving, as shown in Fig. 3. Practically the same result is sometimes obtained by running the horizontal portion just above the paving and allowing it to become covered with soot and ashes.

In any case the blowoff pipe should be protected by a sleeve of cast-iron pipe of sufficient size to provide an air space of at least one-half inch around it. Even though the pipe is carried below the paving, as in Fig. 3, it is necessary to make some arrangement for freely admitting air within the sleeve surrounding the vertical section, which may be done by making a brick or concrete channel around the horizontal pipe, which will connect with the vertical sleeve, as indicated. Sometimes a V-shaped brick pier is built on the fire side of the pipe, thus protecting it from the direct action of the burning gases, as shown in Fig. 4.

A matter of great importance in the installation of blowoff piping is proper threading at the joints, and many serious accidents have been due to neglect of this precaution. Care should be given to this work, the threads should be full and perfect and have such a taper that the pipe will enter the fitting or valve to a sufficient depth to make a strong and durable joint.

Unless the pipe is carefully protected and blown out at frequent intervals, there is danger of its becoming overheated and burning out. When sediment accumulates it, of course, diminishes the amount of water in the pipe or practically excludes it in some cases, so that there is no way of carrying away the heat and the pipe becomes white hot and softens, thus making rupture an easy matter. This danger is frequently guarded against by the piping arrangement shown in Fig. 5, which sets up sufficient circulation to prevent the accumulation of sediment or overheating of the pipe.

A pipe may burn out even though there is no sediment present, owing to the formation of steam which forces the water back into the boiler and leaves the pipe exposed to the full heat of the fire without any means of cooling it. This condition may be prevented by making a steam connection with the blowoff pipe, either inside or outside the setting, as shown in Figs. 6 and 7. This carries off the steam as fast as it is formed and thus prevents the water from being forced out of the pipe. When there is much sediment, the plan shown in Fig. 5 seems preferable, because it not only guards agains the plugging up of the pipe, but also prevents boiling and the formation of steam; the arrangement shown in Fig. 6 only prevents one undesirable condition.

The arrangement shown in Fig. 7 also combines a surface blowoff for removing any scum that may form on the water owing to the presence of organic matter. The collecting nozzle has considerable width so as to extend partly across the boiler and is often carried on floats, with a flexible connection so as to always be in a position to catch the scum whatever the elevation of the water level.

No bolted flanges should be located where exposed to fire, although a certain number will be found convenient outside the setting for use when disconnecting for repairs. The reinforcement, where the blowoff pipe is connected with the boiler, should be drilled and tapped as a unit with the shell, instead of being punched to a larger size as is sometimes done. In this way a threaded joint of sufficient length for proper strength may be obtained.

Whenever the pipe is placed as in Fig. 4, the sleeve surrounding the horizontal portion should be brought out through the brickwork, in order to provide a good inlet for the circulation of air. A typical arrangement for the piping connections outside the setting is shown in Fig. 10. A cock and valve are used in this case, with the former next to the boiler. When used, the cock should be opened first and closed last, when no water is passing through it, thus greatly reducing the wear, as there is no scoring of edges or ground surfaces. The same method of operation applies when two blowoff valves are used instead of a valve and cock. In some cases the cock is left open at all times, thus being kept in condition for cases of emergency only.

By using a plugged tee instead of an elbow, as in Fig. 8, it is possible to remove the plug and detect leaks in either cock or valve. It is also possible to insert a rod for the removal of scale in case the pipe should become plugged, it being understood, of course, that the pressure on the boiler has been brought to zero before opening the valves. The connection from each boiler is best brought into the main pipe on an angle by means of a Y-fitting in order to reduce the chances of clogging.

A common arrangement for a low-pressure heating system, where the condensation is returned by gravity through the blowoff pipes, is shown in Fig. 11, in which case any unit may be blown off independently of the others and without reference to the return, by closing valve *A* and opening cock *B*.

When practicable, it is better to let each boiler have a separate discharge, either into a trench in the open air or into the sewer. In most localities the latter method is prohibited by ordinance because it is more or less injurious to the sewer. In such cases an intermediate blowoff tank is necessary, to which all the boilers are connected by a header or main common to them all. A typical blowoff tank is shown in Fig. 9 and should be so constructed as to permit the steam and water to separate, the former escaping to the atmosphere through a vent, and the water into the sewer under the combined influence of gravity and such pressure as may exist in the tank. The shell is commonly made of ⅜-in. iron or steel, with ½-in. stock for the heads. With a 2-in. inlet the outlet should be at least 3 in. and with a 2½-in inlet, a 4-in. outlet. The vent is commonly made about an average of the inlet and outlet, although it is frequently given the same size as the latter.

A boiler should never be blown off into a tank that is already full of water or nearly so, because the violent discharge of more water is certain to produce a considerable increase in pressure, especially before a flow has been established through the outlet. Under such conditions the pressure in the tank may approach that in the boiler, and this fact, taken in connection with the known law that a sudden load or pressure has twice the effect of an equal load when applied gradually, goes to show how serious may be the consequences of blowing off suddenly into a tank that is already full.

Water Rheostat for Testing 2400-Volt Three-Phase Generators

By C. E. Inman

A novel rheostat was used by the writer some time ago, when it became necessary to test three-phase 60-cycle 2400-volt generators installed in a hydro-electric power house before enough load was obtainable to use the current capacity of one machine. There were three units—one generator of 850 and two of 1250 kv.-a. each.

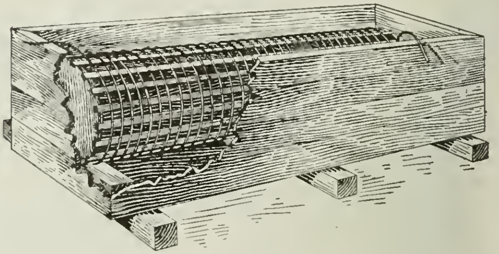


FIG. 1. COIL OF IRON WIRE IN TUB

Three tubs were obtained, formerly used in a dyehouse, which were 21 ft. long, 26 in. wide and 26 in. deep. In each tub was placed an open spool, or reel, 18 in. in diameter, on which was wound 2100 ft. of No. 8 B. & S. gage galvanized steel wire, as in Fig. 1, care being taken to keep the wires evenly separated. The coils in the three tubs were connected in star for the 850-kv.-a. generator and in delta for each of the 1250-kv.-a. units.

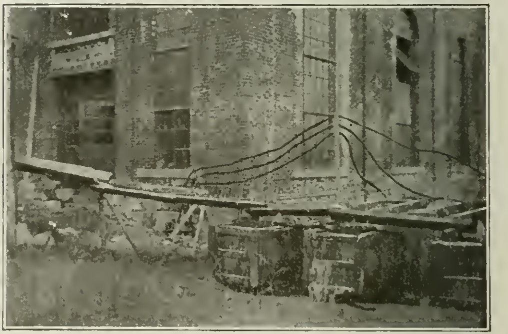


FIG. 2. GENERAL ARRANGEMENT OF RHEOSTAT LOCATED OUTSIDE OF POWER PLANT

Water for cooling purposes was obtained from the forebay, the tubs being allowed to run over enough to keep the temperature down on the coils. A view of the general arrangement is shown in Fig. 2. Each generator was allowed to run as long as necessary, and the rheostat gave satisfactory results.

Oil can be removed from feed water by filtration, the common practice being to place the filter between the steam pump and the boiler. There is really no excuse for allowing oil to enter a boiler in such quantities as to be a menace to its safety or to cause damage as will necessitate expensive repairs.

Reagan Automatic Stoker

That attention is being given to boiler-room economy is evidenced by the numerous designs of mechanical stokers that have been developed during the last few years and to improvements of existing stokers. The more simple a stoker can be made and at the same time operate efficiently, the better. The less room it requires in a boiler house the more popular it will be, the more automatically it will operate, the higher its standing among engineers and the higher rating at which a boiler can be made to operate with it, the more efficient it will be.

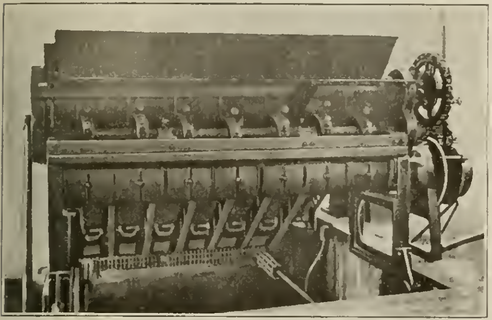


FIG. 1. FRONT VIEW OF THE NEW REAGAN AUTOMATIC STOKER

When the Reagan automatic stoker was in the process of development, the foregoing features, together with others, were kept in mind, with the result that a new stoker has been designed, that its makers, the Reagan Grate Bar Co., Pottstown, Penn., claim is not surpassed by any other.

The new stoker is a self-contained unit, carrying its own forced-draft apparatus. It has an adjustable feed of from 0 to 60 lb. of fuel per square foot of stoker surface per hour, is equipped with a mechanical ash unloader, water-cooled water beam under the rest grate and water-cooled bridge-wall and ash-pusher.

The stoker, Fig. 1, extends 33 in. from the front of the boiler setting proper, and is so designed that no fuel siftings can fall into the space under the grate. All parts are interchangeable. The stoker can be made in any size up to that sufficient to operate with any boiler horsepower. Burning 45 lb. of coal per square foot of stoker area per hour with 7/10 in. of forced draft in the air ducts and 2/10 over the fire requires but ¼ hp. to operate the stoker. A shearing pin that extends through a suitable hole in the sprocket wheel and into a flange secured to the driving shaft prevents damage to the stoker due to foreign material in the coal or any other cause. The pin can be removed with the fingers, and the sprocket wheel then runs loose on the shaft.

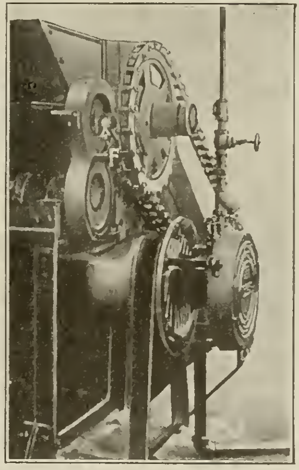


FIG. 2. SHOWING GEAR DRIVE OF ECCENTRIC SHAFT

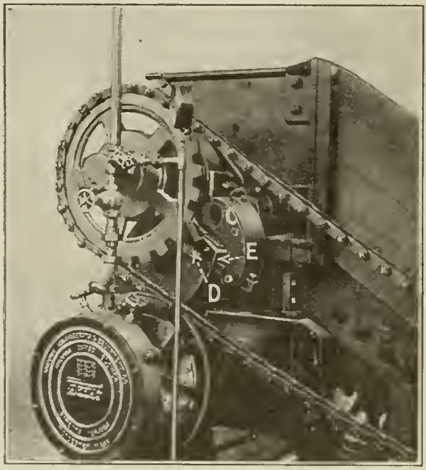


FIG. 3. SHOWING BLOWER, SPROCKET DRIVE AND FEEDER BLOCK DRIVE

Coal is fed into the hopper, from which it is pushed out on the coking block *A*, Fig. 4, by a reciprocating semicircular feeding block *B*, which receives motion from a shaft that extends across the stoker below the hopper and which is driven by a sprocket wheel on one end that is chain-driven from either a motor or engine. The outer end of the feed shaft is fitted with a trigger arm *C*, Fig. 3, forked at the bottom and in which fork the ratchet connecting-rod *D* runs and is supported by a pin. Regulation of the pusher member is obtained by the adjustable head *E*, which carries a lever *F*, Fig. 2.

By lifting the ball end of the lever, the teeth on the other end are disengaged from the teeth on the upper side of the connecting-rod *D*, Fig. 3, thus permitting the lost play between the head *E* and the stop on the end of the rod *D* to be made more or less. With the head *E* close up to the crank, the pusher will be moved full stroke; any additional lost motion between the head *E* and the crank will reduce the stroke of the pusher, thus admitting of an adjustment of from no feed to full capacity.

Fuel is first fed into coking plates *A*, Fig. 4 and then travels to the bottom of the stoker inch by inch, owing to the movement of the step-plate sections, the number of which depends on the size of the stoker.

Not only can the initial feeding of the coal be regulated by the adjustable feeding device, already described, but a similar eccentric arrangement actuates each step-plate section, thus permitting their individual movement to be regulated independently of one another and separately from the feeder. By means of these refinements the stoker can be made to feed any amount up to 60 lb. of coal for every square foot of stoker area.

Each step-plate section is supported on the under side by small trolley wheels that travel on a trolley track. Air from the self-contained blower is delivered through air ducts to the air openings in the step plates. These plates are made in sections that are easily and quickly removed. They overlap, thus preventing siftings of fuel in the air duct. The faces of the step plates are made with ½-in. diameter holes, each about 1 in. deep

These holes fill with ashes and protect the metal against burning. One-fourth inch air holes are distributed between the ash holes, through which air and steam are admitted to the fuel bed.

Air is supplied by a self-contained turbine-driven blower.

The air, going through a main windbox *H*, Fig. 4, and passing through the hollow mouthpiece *I*, enters the air ducts that extend the length of the step-plate section and then escapes through the airholes in the step plates. Not only do the airholes supply the necessary air for combustion, but they also feed steam coming either from the stoker engine, fan turbine or from an auxiliary source. The steam is discharged into the air ducts through perforated pipes and escapes through airholes to the under side of the fuel, forming a water gas. This steam also escapes through openings at the bottom of the grate and acts to rot such clinkers as may form. The steam, together with the oscillating movement of the step-plate sections, prevents the formation of clinkers.

No ashes can be deposited in the space below the stoker, as any slight siftings that might occur go into the air ducts. This slight accumulation is blown out when a sliding gate is pulled out at the bottom of the air ducts.

From the water-cooled rest grate *G*, the ashes drop into an ashpit from which they are removed by a mechanically operated ash pusher head *K*, Fig. 4. This ash pusher runs on trolley wheels and tracks and is water-cooled. It is actuated by means of follow rods, Fig. 4, one on each side, and which are con- through the bell crank *M* and sliding rod *N*. It is capable of handling 1500 lb. of ashes at one movement.

When it is desired to remove a portion of the ash accumulation, a pin *O* is inserted in the rods *P* and *N*, the former fitting into the hollow rod *N*. A downward movement of the rod drags the head *K* to the end of its track and pushes a slug of ashes out into the ashpit. One revolution of the crank *R* removes the pusher head out and back from and to its position in the bridge-wall, as shown in the illustration, where, when it is not in use, it is fully protected from the furnace heat.

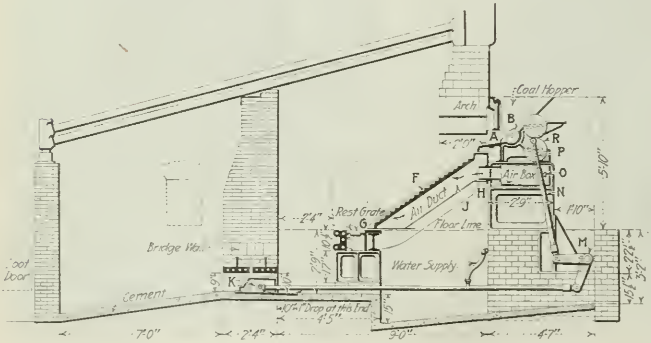


FIG. 4. SECTIONAL ELEVATION THROUGH THE REAGAN STOKER

Not only is the rest gate and ash-pusher head water-cooled, but that part of the bridge-wall immediately over the ash-pusher head *K* is also cooled by circulating water.

In Fig. 5 is shown a plant of the water-cooled system. Water enters the bridge-wall beams, as shown, through the pipe *A* and after making eight passages through the bridge-wall is piped to the water beam of the rest gate, where it makes five passages and then flows to the inlet side of the hollow ash-pusher rods and passing through the pusher head discharges into a hotwell, from which it is pumped for boiler use.

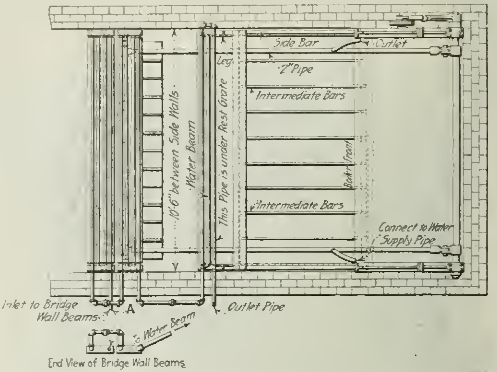


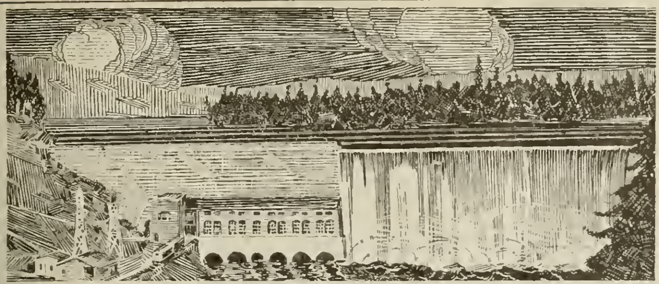
FIG. 5. SHOWING WATER CIRCULATION THROUGH BRIDGE-WALL. WATER BEAM AT REST GATE AND ASH-ROCKER HEAD

In an address regarding England's economic problems C. A. McCurdy, parliamentary secretary to the British food controller, said: "Every year we use in England 80,000,000 tons of coal for motive power to drive machinery to help the workers to produce the things we want. Man for man we use in industry half as much coal again as they do in America, but we do it so badly, so wastefully, that one ton of coal used to assist the worker in the United States gives him 50 per cent. more help, 50 per cent. more motive power, than 1½ tons used to assist the British worker."

In the early day of the development of electrical machinery it was not uncommon to use sheets of pure mica for insulation that were 10 or 12 in. square. The available large sheets of pure mica have been so reduced that a sheet 10 in. square is looked upon as a curiosity, yet the use of mica has increased many hundred tons.

A young chemist who started out 30 years ago to manufacture coach varnish became the head of the pioneer firm devoted exclusively to the production of insulation varnish for electrical machinery.

With the high cost of bituminous coal, power-plant operators are investigating the possibilities of fuel oil. It is necessary, of course, to make provision for storing the oil, and a common size of storage tank that is used holds about 10,000 gal. One 8 ft. in diameter and 30 ft. long will have this capacity. Such tanks are provided with a manhole, a filling connection, a suction connection, vent opening, and a connection for steam-heating coils. Fuel-oil tanks are generally placed below the level of the boiler and oil pump.



POP'S WATER-POWER COURSE

By

John S. Carpenter

"THIS time we tackles the subject of regulation," began Pop. "By that we means regulatin' the water quantity supplied to the wheel or turbine so the speed can be kept as constant as possible. Seein' as how we has jes' gradyated from the study of Pelton wheels, we will take them up first, 'cause in some respects the regulation of typical Pelton-wheel plants offers some of the prize puzzlers."

"I suppose, Pop, that the proposition isn't much different from the problem of governing a steam turbine. A set of flyballs, a little throttle valve, a couple of levers and rods—and there you are!" Jimmy affected the confident, easy air that cub salesmen spring on Pop—to their sorrow.

"Well, young feller, you jes' ain't all there! See?"

"No, I don't see; tell us all about it," said Jimmy.

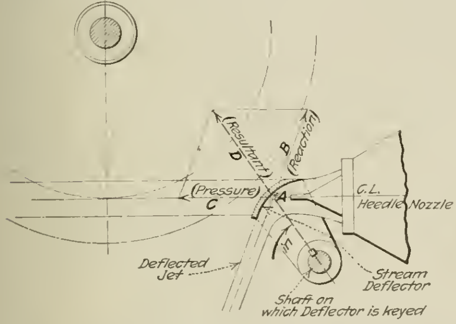


FIG. 1. BALANCED STREAM DEFLECTOR

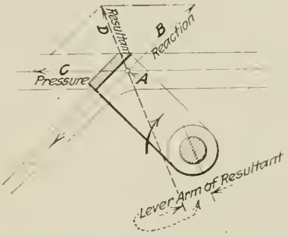


FIG. 2. UNBALANCED STREAM DEFLECTOR

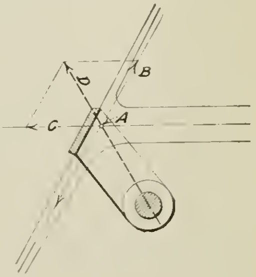


FIG. 3. "FAKED" STREAM DEFLECTOR

"First, steam an' water is two different critters. One is like a pet cat, t'other's a derned circus mule. You take, fer instance, a cubic foot of steam at 200 lb. gage an' it don't weigh even a half a pound, while with water, for all practical purposes, it weighs about 62.35 lb. per cubic foot whether it's under one-foot head or two thousand! It's the mass in water that counts. You know dern well you can shut down a pipe havin' steam flowin' in it at the rate of 15,000 ft. a minute purty quick, even if it's toler'ble long; but let me ketch you tryin' it on any of the water lines 'round this here plant! You know it's gotta be done easy or ten chances to one you'll bust a few fittin's.

"Now we'll take a little case. We'll assume, to start the scrap, that we have a turbine plant in which the turbine is fed by a pipe line, the length of the same bein' about three times the head—an average case. We is runnin' purty near full load, an' now comes a slump—say 50 per cent. load off. The first thing that happens is that the speed rises. If we had no governor on the unit, it would theoretically rise 100 per cent.; actually, it rises much less, 'cause the efficiency drops off a lot when the wheel is overspeeded, on account of shock on the runner vanes. But we have a governor—say it's jes' a set of flyballs and a throttle valve. The speed havin' increased, the governor moves the throttle valve toward the closed position. Remember the velocity in the pipe line is now only about half of what it was before 'cause we is usin' only about half the previous amount of water. Now the other half of the velocity has to be destroyed in some way. It can't escape, so it commits suicide by stretchin' the pipe an' increasin' the pressure head. Now, as soon as the pressure is increased it takes less water than before to carry the load an' keep up the speed. The speed rises again. The governor shuts the throttle valve still more. By this time the pressure wave has reached the bottom of the pipe line an' is now bein' reflected up to the forebay, so the pressure head goes down now and the speed will drop, causin' the governor to open the valve again. An' so this seesawin' will continue until the load shifts from one generator to the others. Sich a condition of affairs is technically called huntin'."

"In other words, with a governor like that you'd be always between the devil and the deep sea," Jimmy summarized. "But now how do they turn the trick?"

"It's done with a dashpot an' a relay or compensatin' device, all of which will be dooly taken up in our next talk. The main thing we has to consider now is how the Pelton wheel is governed. In order to understand anything about the proppysition at all, I had to give you a little idee how it's pulled off.

"Take a look at Fig. 1. Here you sees what is called a stream deflector. It does jes' what it says—deflects the stream. Now they is two kinds of stream deflectors. One is made very cheap by bendin' a piece of flat bar iron into a U-shape. If you feels kinda particular you might sharpen up the edge that cuts into the stream. Now that kind is dern hard to operate, 'cause it ain't balanced, a good deal like comparin' the old-style slide valve to the purty balanced piston-valve gears of today. An' t'other kind—yes, you guessed it, son—t'other kind of stream deflector is balanced and easy to operate."

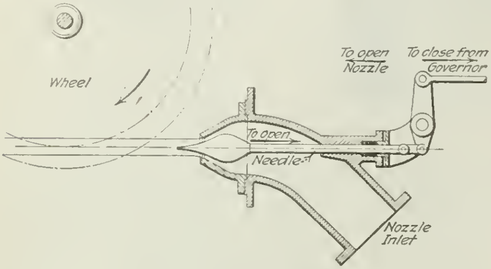


FIG. 4. PLAN OF DIRECT NEEDLE CONTROL

"How can a fellow tell if the thing is balanced or not? And how can you figure the pressure of the jet on the deflector?"

"To tell whether a stream deflector is balanced or not, you don't have to go an' figger stream pressures. It can be done very simple. Jes' take, an' turn to, an' go to work an' draw a line through the center of the deflected jet and one through the middle of the stream. From the point *A* where they intersects on the center of the stream, you measure off, say, one inch an' draw in that line kinda heavy. Now do the same with the other center line you drawed through the deflected jet. Then you has two lines of force, *B* an' *C*. We completes the parryllelogram as shown, an' we gits the resultant of them two forces *B* an' *C*. I don't care what the resultant is, whether it represents ten pounds or a thousand—at least not for this purpose."

"Yes, but what do those lines represent, Pop, and why are they equal?"

"Them lines, son, is the stream pressures drawn to scale. They is equal by Newton's law, which says every action has an equal an' oppysite reaction. All I wants to know is, when I lengthen out that resultant *D*, is it gonna go through the center of the deflector shaft or ain't it? If it does, then the critter is balanced. If it don't, then you'll find it has a tendency to turn either one way or t'other an' your governor has to keep it in that position. When the resultant goes through the center of the deflector shaft, then the governor only has to take care of the friction in the bearin's. This kind of deflector ain't balanced in *all* positions, but when it is cuttin' into the jet about all the way, that's the only time the pressures amount to much, and then it's so near balanced they ain't no fun arguin' over it. Doin' the same trick with the critter made outa a piece o' flat iron, shown in Fig. 2, you sees the resultant goes off to one side of the shaft center. You can make the resultant go through the center of the shaft by bendin' the part that cuts in, as in Fig. 3, but then some of the water actually will shoot out of the top of the dingus an' it'll be unbalanced in actual practice.

"It's only fair to say," Pop continued, "that this balanced stream deflector is patented, an' the patents is owned by the Pelton Waterwheel Co."

"If I get your sketch in Fig. 4 right, it's a needle nozzle directly controlled by the governor. Darn if it isn't simple!" declared Jimmy, relighting his cigar.

"It is, if the pipe-line conditions let you use sich a riggin'. S'posin' they is a long pipe line, say five thousand feet long, an' the water in it has a purty good velocity—fer instance, call it six feet at full load—then you couldn't use an arrangement like that nohow! If you shet the water off quick you'd prob'ly soon be writin' out a requisition fer a new pipe line if you stood in well with the boss, or else be huntin' an' outa-town job, if the boss liked you middlin' to punk. We'll see later on how a heavy flywheel helps sich a plant."

"One great big advantage that I can see in the method of direct governing by the needle is that it saves the water which the stream deflector wastes," Jimmy observed with great dignity.

"Yes, that's so. The point here is that the stream deflector don't change the velocity of the water in the pipe line, and so don't create any jimjams in the regulation problem with pressure rises that could jes' as well be left out so far as good regulation is concerned. In sich doin's an ounce o' prevention is worth a hull ton o' cure. In the wild an' woolly West they has plants on some o' them rivers that has to be used fer irrygation. So on sich plants the water must be kept agoin', an' they has laws which says it can't be shet off. So you see in them cases you gotta use some kinda hickey which don't shet the water off, but deflects it off'n the wheel.

"An' now, about the regulatin' with the needle, or usin' another name, the water-economizin' nozzle. You really can use it on any plant where the law allows you to shet the water off, provided you opens the nozzle quick and closes it gradual. Openin' it quick, of course, makes the pressure go down, an' the flywheel capacity of the rotatin' parts has to carry the load fer a time over the slump, but it ain't as bad as when the pressure goes way up on account of changin' the velocity in the pipe line.

"Right here I wanta say a few things on the subject of the relief valve. The idee is that when you has a long pipe line an' the velocity must be changed quick from fast to slow, a relief valve set on the lower end of the line will help matters a great deal. The great trouble is to git enough relief valves to handle the pressure increase. The valve used is most gen'ly boiler-type with a fair-sized lip on the valve so the pressure can vary a few pounds without makin' the valve pop all the time. The minute sich a valve opens, it's gonna stay open till the pressure gits three to five pounds below what it's set to blow at—on account of the extry area of the lip—

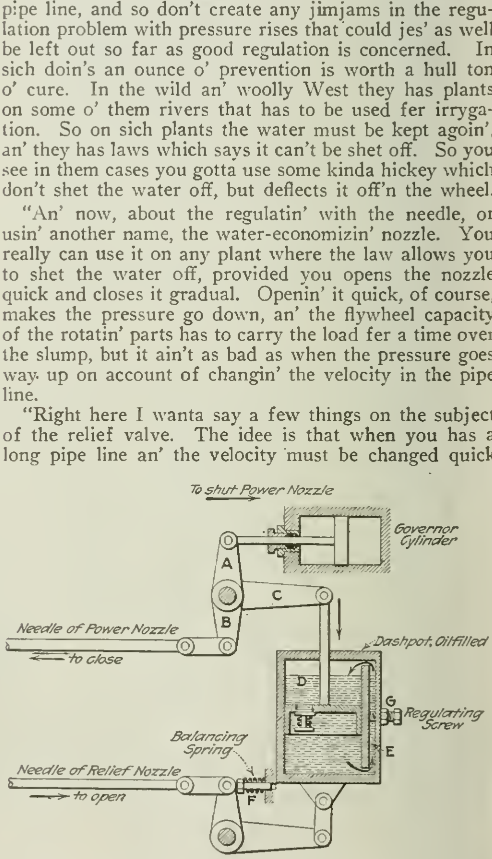


FIG. 5. SYNCHRONOUSLY OPERATED RELIEF VALVE

which it wouldn't do if the valve didn't have any lip to it."

"You mean, Pop, that if the valve didn't have a lip it would be chattering all the time as soon as the pressure got high enough to overcome the force of the spring and the friction in the valve parts."

"Uh-huh," mumbled Pop; "that's right. Many engineers has serious objections to the idee of a relief valve that gits its cue to git busy from the pressure rise alone. The valve might stick fer some reason or other and then the pipe line might go up in smoke. These gents demands somethin' that goes on the job as soon as the governor moves, that will open as much area to relief as the governor shuts down on the power nozzle. They calls these the synchronous relief. To put it plainer, let's say the governor starts to close the nozzle, due to a drop in load. In the first instant of time, we'll say the governor closes off two square inches of nozzle area. Now, in order to keep the pipe-line velocity the same, the relief nozzle must open up two square inches of area at the same time, an' so on. When you has a riggin' that will do that, you don't at least theoretically, git any pressure rise, 'cause you ain't stoppin' the flow in the pipe line. Now, to save water they is a dashpot usually provided that will close the relief nozzle very slowly so the velocity will be very gradually changed.

"Consider Fig. 5 careful-like, Jimmy. Let the force of the governor be applied at the lever *A*, the same movin' the levers *B* an' *C* as shown. We'll say the governor starts to close the nozzle used fer power. At the same time the end of the lever *B* moves to the left to shet off some area, and the lever *C* moves downward to open the relief nozzle. Now, you'll see that the valve *D* in the piston of the dashpot would only open if the piston moved upward, an' since in this case it moves down, it tries to force the oil in the dashpot through the narrer port *E* at the side. This takes so much force that the lever shoves the hull dashpot down without movin' the piston relative to the cylinder. For the time bein' it might jes' as well be a rigid connection between the two levers, as the governor works so fast the oil ain't got time to beat it around to the other side of the piston. The relief nozzle is now open and dischargin' as much water as the governor shet off on the power nozzle. You'll notice, son, a spring *F* behind the lever that controls the relief nozzle. This spring should be jes' strong enough to balance the thrust of the needle, the weight of the dashpot cylinder with its link and lever, plus a small amount extry for friction. So jes' as soon as the governor is done movin' the piston the spring slowly returns the dashpot cylinder upward, which closes the relief nozzle. The time of closing is regulated by the little setscrew *G* on the dashpot and the adjustin' nut on the spring *F*.

"When the call is for more juice, then the governor opens the power nozzle more; at the same time the dashpot piston moves up very fast because the valve *D* opens and lets the oil through from the upper to the lower side of the piston, the result bein' that the dashpot cylinder remains stationary and the relief-nozzle needle is not moved. So we fulfills the conditions of quick opening in response to the call fer more juice, and in the case of load off the power nozzle is quickly closed and the relief nozzle slowly shet down without injury to the pipe line. The next time we meet we'll study the oil-pressure governor."

The Electrical Study Course—Fundamental Principle of the Transformer

The advantages of transmitting power electrically at high voltage is shown by examples, and then the fundamental principle of the transformer is discussed.

THE transformer is a device for changing the voltage of alternating-current circuits. The advantages of making such changes are manifold, but their particular usefulness is in their application to electrical transmission. By means of their use it is possible to generate the electricity at a moderate voltage, then increase the voltage, and transmit it at high pressure to the point of demand, where the voltage can again be reduced to a value that is safe to handle. The advantage of transmitting electrical energy at a high voltage will be made apparent from the following:

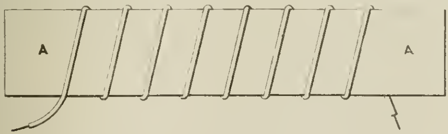


FIG. 1. COIL OF WIRE ON IRON CORE

Assume that we have a line of No. 4 wire one mile long, over which we wish to transmit 500 kilowatts. If this power is transmitted at 50,000 volts, the current would be $\frac{W}{E} = \frac{500 \times 1000}{50,000} = 10$ amperes. The loss in the line would be $I^2 R$, where I is the current flowing and R the line resistance. The resistance of 2 miles of No. 4 wire is 2.572 ohms. Hence $I^2 R = (10)^2 \times 2.572 = 257$ watts. If, on the other hand, we were to transmit at 10,000 volts, we would have $\frac{W}{E} = \frac{500 \times 1000}{10,000} = 50$ amperes, from which $I^2 R = (50)^2 \times 2.572 = 6430$ watts. At 1000 volts, $\frac{W}{E} = \frac{500 \times 1000}{1000} = 500$ amperes, giving $I^2 R = (500)^2 \times 2.572 = 643,000$ watts; that is, we would lose more than the total amount of energy we are trying to transmit, which is impossible.

Another way to look at the situation is, that for a certain allowable loss in the line we can use a much smaller wire at a high voltage than we can at a low one, since the current varies inversely with the voltage. Thus, in the foregoing examples, when $E = 50,000$ volts, $I = 10$ amperes; when $E = 10,000$ volts, $I = 50$ amperes; and when $E = 1000$ volts, $I = 500$ amperes. If we wished to limit the line loss to 5 per cent., it would be $0.05 \times 500 \times 1000 = 25,000$ watts. At 10 amperes we have $(10)^2 \times R = 25,000$ watts, or $R = \frac{25,000}{100} = 250$ ohms, making the resistance per 1000 ft. equal to

$\frac{250}{5.28 \times 2} = 23.67$ ohms. From the wire table we find that a No. 24 wire would serve. At 50 amperes we have $(50)^2 \times R = 25{,}000$ watts, or $R = \frac{25{,}000}{2500} = 10$ ohms, making the resistance per thousand feet equal to $\frac{10}{5.28 \times 2} = 0.947$ ohm, requiring a No. 10 wire. At 500 amperes we have $(500)^2 \times R = 25{,}000$ watts, or $R = \frac{25{,}000}{25{,}000} = 1$ ohm, which causes the resistance per thousand feet to be $\frac{1}{5.28 \times 2} = 0.0947$ ohm, corresponding to a No. 0 wire.

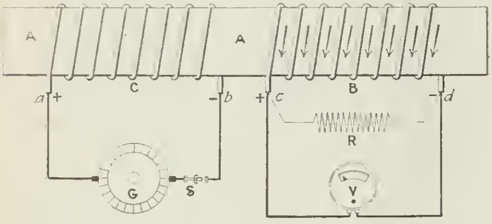


FIG. 2. TWO COILS ON IRON CORE.

The conclusion to be reached from the foregoing is, that by transmitting at a high voltage we can either save on the loss in the line for a given size wire, or we can use a smaller wire, and therefore save in construction cost, for a given allowable line loss. The fact that we can readily "step up" and "step down" alternating voltages by means of transformers gives alternating-current practice its greatest advantage over direct current, for with direct current we cannot use transformers. The only method of raising or lowering direct voltages is to use motor-generator sets, and the voltage on these is limited by the fact that commutators must be used. Even if that difficulty did not exist, we would still be confronted with the fact that the motor-generator set requires an attendant, whereas the transformer does not. That is, in a transformer we can convert from one voltage to another without the use of any moving parts whatsoever and, moreover, without any electrical connection between the two voltages. How this is possible is brought out in what follows.

If current is passed through a coil such as that shown in Fig. 1, the iron core *A* becomes a magnet. Suppose such a coil to be wound upon the same core with another coil *B*, as in Fig. 2. At the moment the switch *S* is closed, a current flows through coil *C*, causing *A* to become a magnet. The magnetic field thus introduced into *B* generates a voltage in it that can be read on voltmeter *V*. This voltage lasts only for the instant occupied to build up the field in *A;* as the field reaches its final value and stops increasing, the voltage at *V* drops to zero again. When the switch *S* is opened and the field in *A* collapses, a voltage is again momentarily generated in *B*. The reason for this can be explained by reference to Fig. 3, which shows a longitudinal section of the coils and core. The magnetic field may be represented by the broken lines. It will be seen that they form loops, as at *L*. When the field begins to build up, these loops, beginning at nothing, expand and in so doing cut across all the wires *W* and *X*. We know that when a magnetic flux cuts across a conductor a voltage is generated in the latter, hence the voltage registered by *V* in Fig. 2. Again, when the field is reduced to zero, as by the opening of switch *S*, the loops of the field in Fig. 3 contract, and consequently cut across the conductors *W* and *X*, as before, but in the opposite direction. Hence, the voltage that appears across the terminals of *B* when the current through *C* in Fig. 2 is broken. Since the lines of force, when contracting, cut the conductors in the opposite direction to that in which they cut them when expanding, it is to be expected that the voltage registered by *V* when the switch *S* is opened is opposite to that which it registers when the switch is closed, and such is the case. Moreover, it will be found that the direction of the voltage in *B* is opposite to that in *C* when the coils are wound in the same direction as they are in Fig. 2. Thus, when *a* is plus and *b* minus, we find that *c* is also plus and *d* minus. This can readily be understood by tracing out the directions of the magnetic fields. If *a* and *b* in Fig. 2 are plus and minus, respectively, as assumed, then the current in the conductors at *T*, Fig. 3, will be into the surface of the paper, and that of those at *U* will be out from the surface. Consequently, the lines of force around the former will be in a clockwise direction and those around the latter in a counterclockwise direction, as indicated by the arrows on the circles around the conductors. It will be noted that all these arrows inside of the coil point from right to left, causing the left-hand end of the core to be a north pole and the right-hand end a south pole. The direction of the line of force outside of the core will therefore be from left to right, as indicated by the arrows on the broken lines. When the field expands upon first being set up, these lines will move down along the core to *S* and will cut the conductors *W* and *X* from left to right. This is equivalent to moving *W* and *X* through the field from right to left. Applying the right-hand rule for the direction of voltage, we find that the voltage generated in *W* is out of the surface of the paper and that in *X* into it. Hence the direction of the voltage in winding *B*, upon closing the switch, will be that indicated by the arrows in Fig. 2.

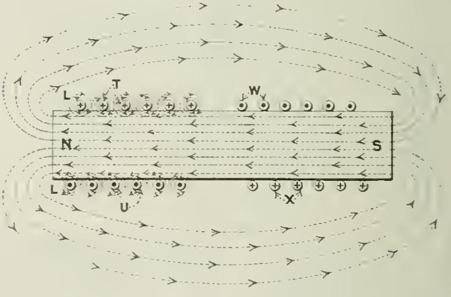


FIG. 3. SECTION THROUGH COILS AND CORE, FIG. 2

Since a voltage is created across coil *B*, it is evident that current would flow through a circuit if connected to it. If the switch *S* were to be continuously closed and opened with great rapidity, a pulsating voltage would be established across coil *B* that would cause a pulsating current to flow through whatever circuit was connected to it. It is therefore apparent that energy from generator *G* is being transferred to the resistance *R*, in spite of the fact that no electrical connection exists between the generator and the resistance. For the continual make and break of switch *S* we can substitute an alternating current. By its use the current through C will continually be made to alternate back and forth, so that the effect is much like that obtained by means of the switch S. However, the switch arrangement is not practicable for anything but very small amounts of power, whereas with an alternating current large values can be handled with entirely satisfactory results.

The preceding problem dealt with a balanced 115-volt, two-phase, three-wire system, the load has a power factor of 88 per cent., each outside wire has a resistance of 0.00467 ohm, and the common wire carries 141 amperes. It was required to find the current in the outside wires, the apparent power, the actual power, and the loss in the outside wires. The current in the common wire of a balanced two-phase, three-wire system is equal to 1.41 times the current in either of the other wires; hence, where I_c and I_o equal the current in the center and outside wires, respectively, $I_c = I_o \times 1.41$, from which $I_o = \frac{I_c}{1.41} = \frac{141}{1.41} = 100$ amperes. The apparent power is the sum of the apparent power in the two phases. The apparent power in each phase is $E \times I_o = 115 \times 100 = 11{,}500$ volt-amperes, or 11.5 kv.-a., so that the total apparent power is $2 \times 11.5 = 23$ kv.-a. The actual power is equal to the apparent power times the power factor. Consequently, actual power $kw. = 23 \times 0.88 = 20.24$ kilowatts. The loss in the lines is found from their resistance and the square of the current carried by them. Since I_o is 100 amperes, and the resistance of each of the outside wires is 0.00467 ohm, we have for the two wires, watts loss, $W = 2 \times I_o^2 \times R = 2 \times 100^2 \times 0.00467 = 93.4$ watts.

The load on a balanced three-phase system is 75 kw., the voltage between terminals 2300 and the power factor 0.65. Find the kv.-a. load and the current per terminal. If the generator's windings are connected in delta find the current per phase.

Fuel Saving in an Ice-Making Plant

By C. T. Baker

It was decided that the plant in question was using too much fuel and steam to produce the rated output, consequently an investigation was undertaken to determine, if possible, some of the causes for poor economy.

The boiler plant consisted of three 125-hp. return-tubular boilers and one compound condensing, Corliss-driven duplex, horizontal refrigerating machine, having two 17x34-in. double-acting ammonia compressors. The usual auxiliaries were installed and were supplied with steam from the boilers, which also furnished steam for reboiling distilled water for ice making. Before anything was attempted in the way of changes, an evaporation test was run on the boilers, all three being in operation at that time. The following results were obtained: Boiler horsepower developed, total for three boilers, 238; percentage of rated capacity developed, 79; water fed to boilers per pound of coal as fired, lb., 5.4; equivalent evaporation from and at 212 deg. per lb. combustible, 7.25 lb.; factor of evaporation, 1.1565; per cent. of ash and refuse in coal, 13.8.

At the completion of this test a careful survey of the plant was made to see wherein improvements could be effected. The first things examined were the boiler settings. It was surprising to note the condition of the brickwork. Holes, large and small, were in evidence everywhere about the settings, and cold air was passing into the furnaces and combustion chambers in large volume. The settings were put in first-class condition, after which the firemen were instructed in the proper handling of the fires and the use of the dampers. Little attention had ever been given to proper instructions in the boiler room and the dampers were never used, all draft control being effected by the ashpit doors.

The next step was the repairing of steam leaks, of which there were several bad ones. By this time it was possible to cut out one boiler, since the stopping of the steam leaks and getting the boiler settings tight had so improved things that two boilers could carry the load without trouble.

Carrying the investigation further it was found that two reboilers were used to reboil the distilled water for the distilled-water freezing tanks and to furnish distilled water for filling the cores in the raw-water air-agitated tank. As the total distilled-water requirements were in excess of the available supply, considerable raw water had to be used in the boilers to make up the deficiency. This was, however, of good quality and did not affect the clearness of the ice to any extent. The temperature of this water entering the reboiler was 80 deg., which of course had to be raised to 212 deg. in the reboiler before being delivered to the pre-cooling and storage tank.

To overcome much of this loss, this makeup supply was taken from the feed-water heater, the water leaving the heater at a temperature of 140 deg., which meant a clear gain of 60 deg., representing the saving of several thousand B.t.u. per 24 hours, depending of course on the condition and amount of raw water used. This change so reduced the work required in reboiling that one reboiler was found ample to properly boil the water, permitting one to be taken out of service.

A still further saving in fuel consumption was effected by substituting exhaust steam for live steam for heating the thawing water at the can dumps.

The steam cylinders, high- and low-pressure, of the compressor, were indicated and the valve setting improved. After making a few minor changes, the second evaporation test was run with the following results: Boiler horsepower developed, total for two boilers, 222; per cent. of builder's rating horsepower developed, 111; water fed to boilers per pound of coal as fired, lb., 6.09; equivalent evaporation from and at 212 deg. per pound of combustible, lb., 8.67; factor of evaporation, 1.1550; per cent. of ash and refuse in coal, 19; kind of coal each test, nut and slack; kind of furnaces, hand-fired.

As it was desired to know what percentage of the steam supplied was used to operate the compressor and what was required to supply steam to the auxiliaries, including the reboiler, a steam-consumption test was made on the main engine at the time of making the boiler tests. In the first test it was found that the steam cylinder of the compressor used 74.9 per cent. of the steam generated, and in the second test, after the changes had been made, the steam consumption was 77.3 per cent., or a difference of 2.4 per cent. The operating conditions, such as pressure, vacuum, speed, output, etc., were substantially the same for each test.

No means were at hand for determining the quality of the steam. However, as a matter of comparison and to show whether conditions were being improved, this information as regards steam quality is not absolutely essential. It should be stated that the steam consumption in the second test averaged 200 lb. per hour less than in the first test.

The low-grade bituminous coals available for fuel in this country vary in heat value from 8000 to 9000 B.t.u., where the high-grade coals vary from 14,000 to 15,000 British thermal units.

Westinghouse Marine Turbine Governor

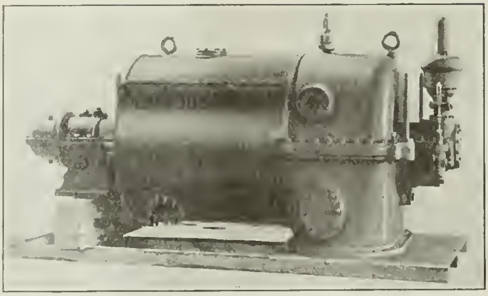


FIG. 1. MARINE TURBINE, SHOWING THE GOVERNOR

With a speed regulation which, with a loaded vessel in bad weather, does not vary more than 2 per cent. above or below normal, nor more than 4 per cent. each way with the vessel running light, a marine turbine governor, Fig. 1, now in successful service, presents noteworthy features. It will not, under any circumstances, shut the turbine down, but will regulate the flow of steam to the nozzles in such manner that the speed is kept practically constant under all conditions. It is made by the Westinghouse Electric and Manufacturing Co. and is used on their turbines of the marine type.

Referring to the diagram, its operation is as follows: A vertical spindle *S* mounted on the forward end of the turbine is driven by a worm gear on the mainshaft at a speed about one-quarter of that of the mainshaft.

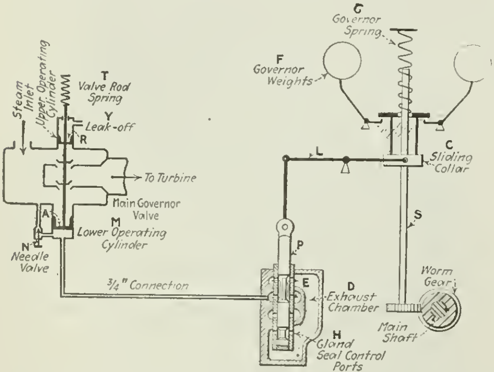


FIG. 2. DIAGRAMMATIC LAYOUT OF GOVERNOR CONNECTIONS

At the top of this spindle is mounted a flyball centrifugal device *F* of the familiar general type. As the speed of the turbine increases above normal and the governor balls are thrown farther away from their center, the sliding collar *C* is raised and accordingly actuates the relay lever *L*, whose fulcrum is near the center, as shown. The piston *P* of a steam relay valve is connected to the lever *L* and moves with it. In this case the piston is depressed, thereby uncovering ports *E*.

Attached to the ports *E* is a ¾-in. pipe connecting with the lower operating cylinder *M* of the main governor valve. This valve is of the double-disk balanced poppet type. On the bottom of the valve stem there is a piston *A*. A second and smaller piston *R* is fitted to the top of the valve stem. The rod of piston *R* extends through a stuffing-box and is attached to one end of a compression spring *T*. These parts are connected together through flexible joints so as to permit the valve to seat squarely and without restriction.

When the turbine is operating under normal conditions, the governor valve is held wide open. The pressures on both sides of the piston *A* are balanced, that beneath the piston being maintained by leakage past the piston together with the steam supply admitted through a small opening in the needle valve *N*.

The upper piston *R* is unbalanced, the lower side being exposed to steam from the boilers, while the upper side is open to the atmosphere through the leak-off pipe *Y*. The downward thrust of spring *T* tending to close the valve is therefore overcome by the upward thrust of the steam on piston *R*, and the valve is held open.

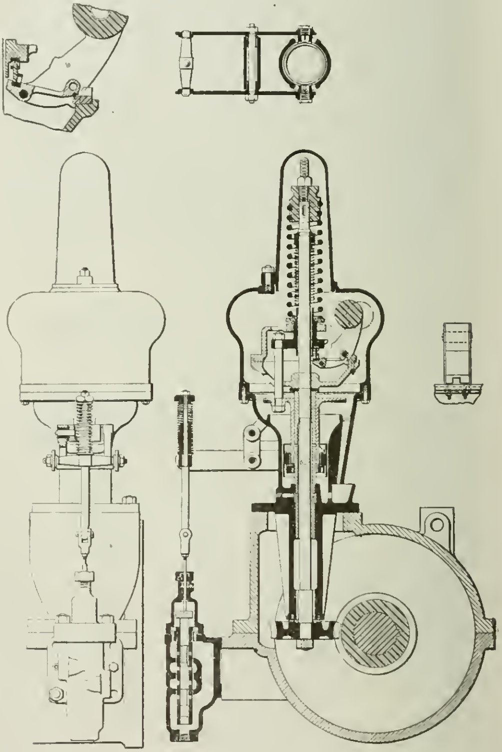


FIG. 3. THE GOVERNOR AS CONNECTED

However, as the relay piston *P* is depressed, opening the ports *E*, a passage is opened from the lower side of piston *A* to the exhaust chamber of the relay. This destroys the balance of piston *A*, and the boiler pressure on the upper side of the piston, aided by the downward thrust of the spring *T*, overcomes the upward pressure of the steam against the lower side of piston *R*, and forces the valve downward, reducing or temporarily shutting off the steam supply to the turbine.

As the speed slows down to normal, the governor weights *F* move inward under action of a spring *G*, raising the relay piston *P* and closing the exhaust ports *E*. The steam pressure under the main governor valve piston *A* is accordingly raised, and the piston moves upward again, opening the main valve as far as may be necessary to admit steam enough to maintain the speed of the turbine at normal.

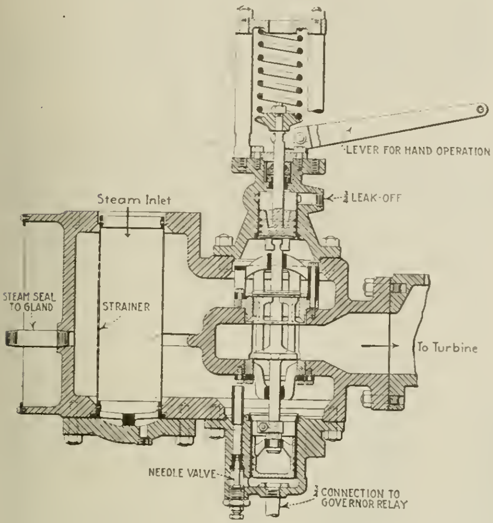


FIG. 4. THE GOVERNOR VALVE.

Another feature of the governor is an arrangement for the automatic control of the steam and water supply to the glands, which prevent leakage where the rotor emerges from the casing on both the high- and low-pressure turbines. The glands are of the combined steam- and water-sealed type. The water gland is designed to effectively seal at all speeds from and above half-speed. Below half-speed the steam seal is used.

To accomplish the gland-seal control in addition to its function of speed regulation, the travel of the governor weights is divided into two zones, one corresponding to a slow turbine speed and the other to a fast rate, the zone division being made possible by two concentric springs on the upper end of the governor spindle. The slow zone spring is smaller and lighter than the other and is placed inside the larger spring. The inner, or slow, travel of the governor weights is opposed by the light spring only. While the turbine is operating at the speed which corresponds to this zone of governor travel, steam seal is used. However, as the speed increases, a point is reached where the steam seal is changed to water, the change being accomplished by incorporating in the governor relay an extra set of ports *H* which, with the relay piston *P*, operate a valve for the control of the sealing function in a manner similar to that in which the movement of the main governor valve is controlled. Fig. 3 is a section of the governor and Fig. 4 a view showing it connected to a marine turbine.

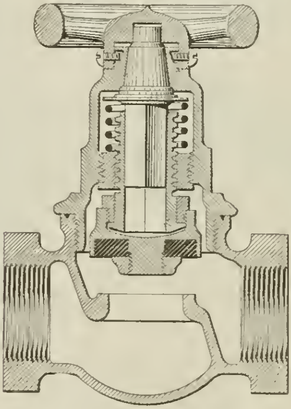
The change from steam seal to water seal takes place at the point where the fast spring zone comes into engagement with the governor weights. The speed continues to increase, however, until the governor takes up its main function of regulating the steam supply to the turbine.

While no attempt is made to obtain extremely close regulation, such as is needed on electric-generator drives, it has been found that the marine governors are very positive in their action and hold the speed of the turbine within very reasonable limits.

Defiance Packless Valve

A packless valve with a metal-to-metal seat at the top of a nonrising stem has been perfected by the Defiance Packless Valve Co., of St. Louis, Mo. It is adaptable for steam, hot and cold water, radiator service, oils and acids. The accompanying illustration shows in section a valve designed for 250-lb. steam pressure. The valve has a one-piece bonnet that is interchangeable with practically all valve bodies on the market.

No packing is employed. The stem acts as a key to raise and lower the valve disk. It is double-seated in the bonnet at angles of 10 and 30 deg. and is held against the seats by a spring. The valve stem is made square in cross-section and of metal harder than the bonnet, to take care of expansion and contraction and to guard against cutting or grinding. Underneath the spring is a threaded sleeve screwed to the bonnet. Within is a second threaded sleeve into which the valve stem enters and to which the valve disk is attached at the lower end. It will be apparent from the construction that turning the handle will raise or lower the valve disk without imparting a similar movement to the stem.



DEFIANCE PACKLESS VALVE

If steam should get past the threaded joint between the sleeve and the bonnet, it will supplement the action of the spring in holding the stem tight against the seats in the bonnet. The valve is dustproof, as the handle plate rests upon the bonnet and is interlocked with it. Another feature is the V-shaped projection on the lower surface of the bonnet shoulder. This jams into the seat on the valve body to form a steam-tight joint.

All of the most successful insulating varnishes are what are known as baking varnishes. Many attempts have been made to produce air-drying insulating varnishes, but up to the present time these have only been successful to a limited degree.

Experience of an Erecting Engineer—Pressing Alternator's Rotor on Shaft

By KENNETH A. REED

Describes in detail how a shaft, 0.025 in. over size, was pressed in the hub of an alternating-current generator's rotor, with inadequate equipment for doing the job.

OCCASIONALLY, an erecting engineer is called upon to do a job that proves to be far more difficult and requires a much greater expenditure than was expected when the estimate for doing the work was made. Perhaps under ideal shop conditions, where every facility, such as a traveling crane, a hydraulic press of proper capacity, calipers of suitable size, various other tools and, last but not least, experienced labor for doing the job, are at hand, it would simply be one of many such operations in a day's work. However, when the same job comes up on the outside, where single pieces weighing several tons are to be handled with a crane of insufficient capacity or no crane at all, and the use of jacks and a large amount of blocking must be resorted to, the problem oftentimes assumes a serious aspect.

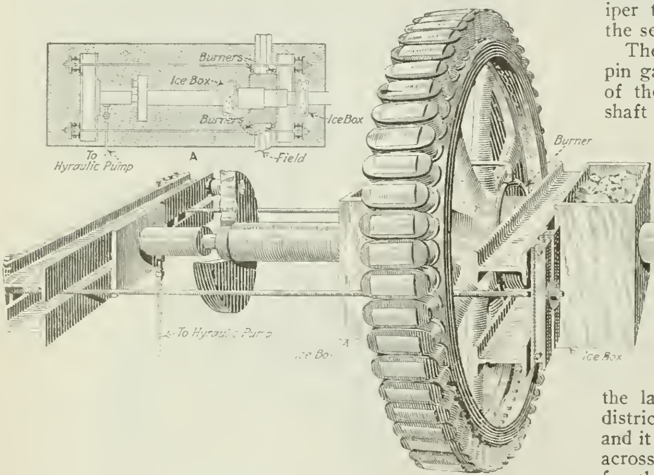


FIG. 1. EQUIPMENT IN PLACE FOR PULLING ROTOR ON SHAFT AND ICEBOXES

One of the most difficult of such jobs that I was responsible for was the pressing of an engine shaft into the field of an alternator. The engine was of the usual cross-compound Corliss type, operating at about 75 r.p.m. The shaft was 26 in. in diameter and weighed approximately 17 tons. The field of the generator was about 14 ft. in diameter, the hub, spokes and rim being a single steel casting with the laminated field poles secured to the rim by means of dovetails and wedges. The complete field weighed approximately 15 tons. The length of the hub was about 18 in., and it was bored to two diameters, as shown at *A*, Fig. 1. That is, one half of the hub was bored to, say, 26 in., and the other half to 26¼ in. The hub seat on the shaft was, of course, turned accordingly, allowance being made for press fit on both diameters. The actual distance that the shaft had to be pressed into the hub was therefore only one-half the length of the latter, while a uniform pressed fit was secured through its entire length.

Under the terms of the contract the manufacturer was to furnish an engineer together with necessary labor and tools for assembling the machine, and arrangements were made whereby some of the customer's laborers could be used. No calipers of proper size could be obtained in the locality where the job was being done, and it was necessary to hire the services of a machinist from a large manufacturing company, which was supplied with such calipers for its own use, in order to check up the diameter of the shaft. It might be explained here that calipering a very large shaft is a rather particular job, inasmuch as the heat from a man's hands will cause calipers of such size to expand and vary several thousandths of an inch. To caliper the shaft correctly, therefore, required the services of an expert in that line.

The engine builder had been supplied with pin gages showing the exact bores of the hub of the field and was instructed to turn the shaft 0.014 in. larger to make proper allowance for a press fit. Upon calipering the shaft, however, it was found to be approximately 0.025 in. larger than the bores of the hub. In view of the fact that it would be practically out of the question to remove the 0.011 in. oversize from the shaft, it was decided to polish both shaft and hub as smooth as possible and take a chance on doing the job.

A 250-ton hydraulic press with round pull-rods 3½ in. in diameter—the largest portable press in the immediate district—had been secured for doing the work, and it was carefully set up, using 8-in. I-beams across the hub of the field and as backstays for the ram of the press, the pull-rods being connected to these two sets of I-beams. The shaft was so long that only one end could be handled by the crane, and this end was the one on which the crank disk had been pressed at the engine works, the other disk having been left off until the shaft was pressed in; therefore it was necessary to support the other end of the shaft on cribbing.

After the key and keyway had been carefully lined up, the exact distance the shaft had to be pressed in marked, and the shaft and hub painted with white lead, the hand pump of the press was started. It seemed as though the plunger of the ram had barely come up against the shaft before the 8-in. I-beams failed. This, of course, necessitated taking the press down and installing larger I-beams. This time 16-in. beams were used, and the shaft went in very nicely for about 3 in., when it practically quit moving, and the pressure, on the press, increased to 145 tons. At this point one of the 16-in. I-beams across the hub failed, and serious troubles began.

In order to make sure that no failure of beams would again occur, it was decided to use 20-in. extra-heavy I-beams across the hub, and behind the ram, with two 10-in. extra-heavy I-beams bolted together and resting across the 20-in. beams, forming the anchor of the pull-rod, as shown in Fig. 1. These beams could not be secured and placed in position until the following day, which of course helped to make the condition worse, since once a shaft is started into the hub it should be kept moving until in place. If for any reason the shaft is stopped, a greatly increased pressure is required to get it started again.

On setting up the press the third time, the distance between the cross-beams was measured accurately at each pull-rod, in order that there would be no unequal strains on the two pull-rods, which might cause trouble. Everything being in readiness, the pump was started and the pressure rose to 260 tons, its maximum safe limit, without the shaft giving any indication of starting. It was then decided to suspend an oak timber 9 in. square and about 20 ft. long from the roof of the power house and use it as a battering ram against the end of the shaft to get it started. Six or eight men were put on the timber, and they swung it back as far as they could and rammed the end of the crank disk, the pressure on the ram still being maintained at 260 tons. The result was anything but that which was desired, and for a few minutes seemed to have been disastrous. Instead of the shaft starting, one of the pull-rod nuts, which was more than 6 in. long, failed with a report like that of a cannon, and the cross I-beams on the pump end swung around, injuring the feet of three of the men who had swung the battering ram. These short I-beams, weighing about 200 lb., against which the nut that failed pulled, were thrown directly back a distance of 20 ft., and landed in a condenser pit. Fortunately, the attendant was watching the job instead of attending to the condenser, and after calling the roll it was a delightful sensation to realize that there were no serious casualties.

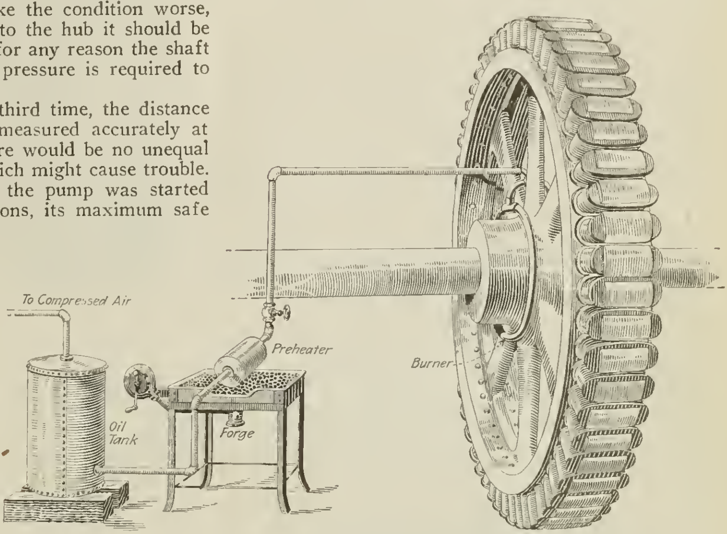


FIG. 2. ARRANGEMENT OF HEATING DEVICE

The prospects were now not very promising in view of the difficulties that had arisen and the fact that the customer was in a big hurry for the machine. However, no time was lost in unnecessary conjecturing, and the problem reduced to one of two things—either secure by express a 500-ton press from a distant district, or devise, on the job, some as yet untried method. The first solution, while being without doubt a certainty, had two serious objections—one being the loss of time necessary to get the press and the other the excessive expense for express charges. These objections made it necessary to adopt the second solution.

During the period of consideration it was remembered that engineers had put in place by contraction bridge spans that were too long and by expansion those that were too short, so it was decided to try such a scheme in this case. Accordingly, boxes were built around the shaft on each side of the hub and packed with ice, as shown in Fig. 1. While the shaft was being chilled, two circular burners, shown in Figs. 1 and 2, were made for the purpose of heating the hub of the field, one being placed on each side, and as near to the spokes as practicable. These burners were made of ¾-in. pipe with $\frac{1}{16}$-in. holes 3 in. apart on the inner side, and the size of the circles was such that the clearance between the burners and the hub was about 3 in. all around. The burners were then piped to a tank and a connection to the compressed-air line in the power house. A piece of pipe about 4 in. in diameter and 16 in. long was placed in the ¾-in. line about halfway between the burners and the tank; and a blacksmith force was placed immediately under this large pipe, as in Fig. 2. This was for the purpose of preheating the oil before it reached the burners.

An additional nut for the pull-rod had been secured, the press set up again, and all checks possible were made to see that everything was just right. Air to the tank was turned on, and after heating the preheater of the feed pipe for some minutes, the burner valve was opened and a torch applied to the burners. Results at this juncture were simply astounding. The entire cribbing and lower part of the field burst into flame, and excitement began to run high. However, no great alarm was felt for the safety of the apparatus, inasmuch as one end of the shaft, as before mentioned, was supported by the crane, and new cribbing could have been placed under the other end had the fire been serious. An ineffective attempt was made to prevent a fire alarm being turned in; fortunately, however, before the fire fighters arrived the blaze had been extinguished without the use of water. An investigation disclosed that gasoline had been used in the tank instead of crude oil as ordered, and that part of the feed pipe beyond the preheater had filled up with gasoline as soon as the air was turned on, and this gasoline had trickled out over the cribbing when the burner valve was opened.

Crude oil was substituted for gasoline, and the burners were successfully lighted without further mishap. The pump of the press was started soon after, and within ten minutes from the time the burners were lighted the shaft began to move under a pressure of

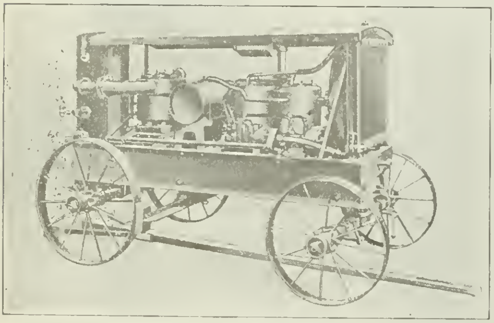
175 tons. Immediately after the shaft started, the pressure dropped to 75 tons, and it remained at from 75 to 90 tons until the shaft was in place. These pressures checked up quite close with calculations made before this scheme was adopted, when it was figured that if a difference of temperature of about 12 deg. could be secured between the hub and the shaft, the press fit would be reduced sufficiently to require not over 100 tons pressure after the shaft had been once started.

Portable Air Compressor

This portable air compressor is all of steel, from its canopy to its broad-tired wheels. The power plant consists of a duplex, vertical high-speed compressor driven by a four-cylinder, four-cycle, tractor-type gasoline motor. The large machine, of 210 cu. ft. capacity, weighs 6000 lb., and the 118-cu. ft. units 4000 lb. The compressor has cylinders cast *en bloc,* with cylinder heads, valve chambers and water-jackets integral. Both intake and discharge valves are of the plate type and are located directly over the cylinder bore. Crankshaft and connecting rods are drop forgings, the air pistons are fitted with three-piece piston rings and, in addition, with an oil-wiper ring. All parts are lubricated by splash from an oil reservoir in the crank case.

The compressor is provided with an inlet unloading device which automatically closes the compressor intake when the receiver pressure rises above a predetermined limit, and permits the machine to take up its load again when the pressure has fallen a definite amount.

Both compressor and driving motor, which are manufactured by the Ingersoll-Rand Co., 11 Broadway, New York City, are water-cooled by a circulating system, with a centrifugal pump, large radiator and powerful blast fan. The radiator is made up of removable sections.



PORTABLE AIR COMPRESSOR

Each unit is equipped complete with receiver, safety valve, drain valves, pressure gage and service valves to which the air-hose lines may be attached.

Motor installations made on 2300-volt circuits have in general been considered more of a fire and personal hazard than low-voltage installation. However, experience has shown that 2300-volt installations when made as required by the National Board of Fire Underwriters' code are as safe as the low-voltage circuits. There is little or nothing on record to show that anyone has received a dangerous shock on the motor side of the distribution switchboard of 2300-volt motor installation.

Alternating Current Motor Starting Switch

It is permissible to start induction motors up to and including 5 hp. and in some localities 7½ hp. by connecting the motor directly to the power circuit. Induction motors of these sizes can be started in this manner without injury. In the past it has been customary to start these motors by simply closing a knife switch or similar device. A new contrivance for this kind of work has been developed by the Electric Controller and Manufacturing Co., of Cleveland, Ohio, to make the starting of these motors foolproof. This device is known as an alternating-current starting switch, is operated by a push-button, and is inclosed in a steel cabinet as shown in Fig. 1, with conduit connection for all wires. A compact push-button arranged for conduit connection, as shown in Fig. 3, is supplied for "starting" and "stopping" the motor. Fig. 2 shows the starting switch with the cover of the box open.

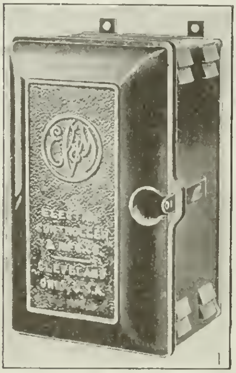


FIG. 1. SHOWING COVER CLOSED

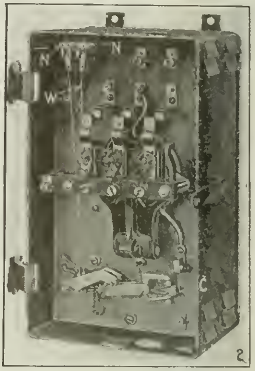


FIG. 2. SHOWING COVER OPEN

The two wires *W*, Fig. 2, extending the length of the slate on the left-hand side, give overload protection of the inverse-element type, both while the motor is starting and while it is running. The principle used is one entirely new in motor-starting practice, but is the same as used in hot-wire ammeters and voltmeters and gives an extremely accurate overload protection, at the same time giving an inverse-time-element feature. These two wires are stretched, and the operating value of the overload protection is adjustable by changing the tension of the wire by the nuts *N*. If too much current is being taken by the motor, these wires will expand, causing the small contact *C* at the bottom to be open, and this will in turn deënergize the magnet coil, and cut the motor off the power line. It is then necessary to push the start button before the motor can again be started.

FIG. 2. PUSH BUTTON

The "safety-first" feature is incorporated in the switch in that the cover in the switch box may be locked and only authorized persons have access to the interior. The motor is started by pushing the "start" button and stopped by pushing the "stop" button. There are no laminations used in any part of the switch, and it is built in sizes up to 3½ hp. for 110 volts and up to and including 7½ hp. for 220, 440 and 550 volts.

EDITORIALS

Combined Issues

SOME five or six weeks ago, when the strike of New York printers had apparently reached a hopeless deadlock, arrangements were made to print *Power* in Chicago, where it is now being handled. In order to catch up with the schedule by the first of the year, it was decided, as previously announced, to combine, two in one, each of the remaining issues of the present volume. But this decision was later affected by the coal shortage, from which Chicago was one of the cities most threatened, because of its almost exclusive dependence upon bituminous coal. As a precautionary measure the regional fuel director cut the working day to six and a half hours in addition to other drastic restrictions.

Therefore, in order to catch up by the first of the year, the *Power* schedule was further modified so that each of the two last issues in December will be a combination of three numbers, the present one including the November twenty-fifth, December second and December ninth, and the final issue the December sixteenth, twenty-third and thirtieth. The sizes of these combined issues have been increased accordingly, so that the reader will receive what ordinarily would have come to him had there been no strike.

Burning Ashes

PLOWING the waves, bleeding a stone, or making a three-weeks-old calf in fifteen minutes are no better expressions for the impossible.

A dozen years ago a cobbler, of Altoona, announced that if ashes were treated with a mixture of common salt and oxalic acid, their value as a fuel would be restored. The utter absurdity of the proposition did not prevent its serious reception, and even such a body as the Board of Education of New York City compelled its use in the power and heating plants of the schools. It was considered by so many with so much credulous interest that *Power* obtained and published expressions from two eminent chemists to the effect that ash could not be made to burn by any such means. The files of *Power* for the latter part of 1907 and the early part of 1908 are full of it. It died out, of course, and the sponsor of the idea committed suicide.

And now it is up again. A correspondent of the Detroit *Free Press* assures its readers that if they will take the ashes that they are now throwing out, moisten them with a solution of one pound of common salt and two ounces of oxalic acid in a gallon of water, and mix three parts of ashes so treated with one part of coal, they will obtain a better fuel than the pure coal itself. He gives the credit for the discovery of this "remarkable secret" to the Altoona cobbler.

According to the *Evening Sun*, of New York, the Board of Education of that city is again in danger of making itself ridiculous. In its issue of December 8, the *Sun* announces that Patrick Jones, superintendent of supplies, has recommended that this solution be again used by the city, asserting that in 1907 and 1908 he tried it and saved 13,000 tons of coal in the public schools. As *Power* remarked editorially at the time, he could have made whatever saving was made just as well by painting the handles of his shovels red and then being careful how they were used. He even refers to a letter which one of his janitors, in his delight at the results obtained, wrote to *Power* about it, but he does not refer to, and perhaps did not know of, *Power's* condemnation of the process.

It ought not to be necessary to say again that all the saving that was ever made by the cobbler's mixture was due to its psychological effect rather than its chemical composition, and that an anointment of toilet water or uric acid would have been just as efficacious.

Redevelop Our Uneconomically Developed Water Powers

EVER since the introduction of machinery into industry the question of a source of power supply has been an important one, and in most cases it was around centers where a cheap supply of either fuel or water was available that large manufacturing communities came into existence. Many of the industries have grown up around the waterfalls of this country, especially those power sites that were easily developed. Unfortunately, many of these developments are like Topsy —"They just grew." The first manufacturer to arrive, built a dam at the most convenient location, dug a short canal to the waterwheel in his factory and began to produce goods. If there was sufficient water at the first dam built, the next manufacturer that came along entered into agreement with his predecessor and located his plant at the other end of the dam or wherever convenient. If it was not possible to do this, another dam was built farther up or down the river, and this process continued until a number of dams had been built across the river within the distance of one or two miles or even less. Most of these developments utilized only a fraction of the total available head of the falls, consequently produced only a small part of the total power available. When these developments were first made, there was no question of power shortage, since the community was small; but eventually these centers grew until the available water power, as developed, was not sufficient for the requirements, and the steam or internal-combustion engine was resorted to, to meet the demand.

Industrial districts located considerable distance from the coal fields have been experiencing anything but what is reassuring in regard to a supply of fuel. Not only has the supply been uncertain as to quantity and quality, but prices have jumped to undreamed of figures. No doubt, when conditions again become normal the supply of coal will also become stabilized, but it is not likely that pre-war coal prices will ever return. In the past cheap coal has been obtained by an intensive working of those fields most easily accessible and cheaply mined. The demands are such that mines more expensive to operate must be worked, with a consequent increase in cost to the consumer. Probably the use of fuel oil will relieve the situation for a few years, but the most optimistic estimates set this period at from five to ten years, after which we shall have to depend upon coal entirely for fuel. The industrial centers that now feel the effects of the present fuel situation will feel it even more when the supply of fuel oil has become limited.

There is apparently one logical direction in which to turn, and that is to the more complete development of the water powers, especially in the industrial districts, and the improvement of those that have been so uneconomically developed in many of the manufacturing centers. Instead of the three or four low-head developments, producing in the aggregate only twenty-five to fifty per cent. of the power available, there should be one development utilizing a maximum head and producing the greatest amount of power available at each site. There are a number of ways in which this could be done. The most satisfactory, no doubt, would be for the manufacturers that control the water rights to coöperate to the end of making the development either through a company of their own interests or in conjunction with some public-utility company. Necessity is the mother of invention, and doubtless necessity will in the near future bring about the economical development of many of our water powers that have been developed along the lines of least resistance and as a result are now producing only a small part of the power available.

Co-operation As a Factor In Improving Power Service

WHEN power is supplied from a direct-current system, the public utility to a very large extent controls all the factors that contribute to a satisfactory service. The power factor of this system is unity under all conditions of load, the starting currents taken by motors are generally not over 125 or 150 per cent. of normal full-load current, and in most cases the feeders are short. Consequently, their inductance is low, and any sudden changes in the load do not cause serious voltage drops near the load, the fluctuation being readily transmitted back to the source of power. Even where starting conditions are severe or where motors are stopped and started frequently, such as on elevators and hoists, the effect of the frequent starting and stopping is not very likely to be noticeable on the system voltage, since high-torque motors are generally used; consequently, the accelerating period is short and the starting current is not excessive. However, in alternating-current systems, the power factor is determined by the character of the customer's load. If the power factor of these loads is low, the volt drop in the line is high for a given kilowatt load. Not only does low-power factor cause excessive voltage drop in transmission and distributing circuits, but it also aggravates conditions by its effect upon the voltage regulation of the transforming and generating equipment. In an alternating-current system, owing to the inductance of the circuit and the low power factor of the load, the volts drop may be 200 or 300 per cent. that in the direct-current system when transmitting the same kilowatt load. The direct-current motor is capable of developing 100 per cent. full-load torque on 100 per cent. full-load current, where with a squirrel-cage-type induction motor as high as 400 per cent. full-load current is required to produce full-load torque. Consequently, if the motor is of comparatively large size, serious disturbances will be caused in the line. This starting current is always at a low power factor, which, in addition to causing excessive voltage drop in the system, seriously affects the regulation of the transformers and regulators.

From the foregoing it is evident that the character of the customer's load has a marked effect upon the kind of power service that may be rendered from an alternating-current system. The power company can install equipment on the system, and does in some cases, that to a certain extent partly overcomes the effects of poor load characteristics, but this all adds to the cost of generating, transmitting and distributing power. The rate for power is controlled in most localities by public-service commissions, and where these commissions are shown that an increased rate is justified, it is generally granted. Therefore, any additional expense that the customer's load may contribute to the cost of producing and distributing power will eventually be reflected back in a higher rate, either in a demand charge, a penalty for low power factor or an increase in the general rate.

Evidently, there is an opportunity for coöperation between the power customer and the central-station company, which will be of benefit to both parties. Already many of the power companies are endeavoring to coöperate with their customers, with a desire to render them an improved service. Unfortunately, not infrequently this coöperation had been looked upon by the customer as something that was to the benefit of the power company only. Two of the most common causes of poor load characteristics met with, are too large size and improper application of motors. Experience has reached a point in industrial application where both of these can be avoided to a very large extent by the proper consideration of the conditions to be met before the making of the installation. With the increasing cost of everything required to generate and distribute power electrically, anything that the power purchaser can do to keep down the cost at his end of the line will have a stabilizing effect in rates as well as help to improve the service.

Costs in Changing From Oil to Coal

ENGINEERS and executives of large power plants, industrial and public utility, are as never before interested in the cost of changing from oil to coal. Some plants are so favorably situated that the cost, in its relation to the duration, price, and delivery assurance, would, even now, form a good investment. These plants are by no means many. One large public-utility plant in New England, for example, happens to be virtually next door to an area which is now covered with tank farms and which will soon be one of the greatest oil depots in the world. This station probably will be burning oil before this gets into print—preparations have all been made. Here no great expense for storage facilities are incurred.

But in plants less favorably located, the cost of storage tanks may make the change of fuels prohibitive. There is great need for cost data and general and detailed considerations of costs bearing on the subject. The figures and considerations should relate to both steel and concrete tanks, to plants on tidewater and inland, to load factors, insurance requirements, etc.

The men who want these data are *Power* readers. We are, of course, anxious to serve them, and to this end we here encourage those who can contribute something worth while to do so. But have in mind that we do not confine ourselves to large plants; costs relative to the small ones are just as urgently needed.

Our observations in New England show that the actual costs in effecting the change are considerably greater than the estimated costs.

CORRESPONDENCE

Engine Crosshead Pounds

In the article "Engine Crosshead Pounds," page 477 in the Sept. 16 issue, Mr. Reed has described a condition that is frequently met with in heavy-engine operation; that is, greater compression is required on the head end than on the crank end. His explanation that the theoretical dead-centers are not the actual ones will not go far in explaining the trouble, as this would require a greater deviation from proper alignment than would be possible in any standard engine designed for true alignment.

I have found this same condition in heavy Corliss engines, and I have explained it in this way: The piston and crosshead with the piston rod move faster when traveling near the head-end center than they do when near the crank-end center. This faster speed produces greater inertia forces, which require greater compression to cushion and relieve the bearings from the pounding action of the reciprocating parts.

If any reader questions this statement and wishes to test it, all that is necessary is to take a horizontal engine and mark the mid-travel position of the crosshead; that is, put marks on the crosshead guide corresponding to the position of the crosshead when the piston is equally distant from both ends of its travel. Then look at the crank and note its position. It will be found that the crankpin is considerably off the vertical line of the center of the crankshaft.

Turning the engine over one center and bringing the crosshead to mid-position again will bring the crankpin directly over or under its position when the crosshead was in mid-position before. This vertical line of crankpin positions when the crosshead is in mid-position will be considerably nearer the crosshead than the vertical center-line of the crankshaft. Then put the crankpin on vertical center-line of the crankshaft and note the position of the crosshead; it will be found to be much nearer the crank-end dead-center. If still in doubt, put the crankpin in the opposite position, but still in the vertical center-line of the crankshaft, and it will be found that the crosshead is in the same position as before, or nearer the crank-end dead-center.

With a heavy flywheel there is almost uniform circular motion of the crankpin, which means that the same time is consumed in passing from the top to the bottom position on the vertical center line of the crankshaft as is consumed in passing from the bottom to the top position. But during this time the crosshead has not been moving the same distance in both cases, for it has a shorter distance to travel in going to the crank-end center and back than it has to travel in going to the head-end center and back to its position corresponding to the vertical position of the crankpin. If it has to travel farther in the same length of time, it must travel faster.

This same condition causes a difference in the diagrams from the two ends of a slide-valve or piston-valve engine. If the valve is set for equal leads, the head-end diagram is always greater than the crank-end diagram because the cutoff is later and not because the valve moved slower, but because the piston moved faster and so got farther in its travel before cutoff occurred.

Peoria, Ill. C. E. Moulson.

Superheated Steam—Why Not?

In the Sept. 16 issue, page 475, I read Robert H. Wyld's letter on Superheated Steam—Why Not? I also read the editorial relating to the same subject under date of July 1.

It is natural for a man in the business to recommend his apparatus, but the operating engineer has to keep his plant running during working hours and either make or superintend repairs. It has been my experience that superheated steam is not good for a flat valve. I took a plant of several thousand horsepower capacity where large reciprocating engines were used. The valve gear showed signs of intense distress, although plenty of cylinder oil was used. An examination showed that the oil was not lubricating properly, so I decided to use a compound product, but of course I knew that I would have to sacrifice superheat to do it.

We cut the superheat down to about 30 deg., and then the oil got to the valve seats. The valve gear eased up and everybody was happy, and the cost per kilowatt-hour did not run up either. I am a believer in superheat, but I do not want it on large units of the flat-valve or Corliss type regardless of what others may do or have done.

I know of one generating station where Corliss engines were operated for years with excellent success. A large turbine was installed, something like 15,000 or 20,000 kv.-a., and of course superheat was necessary. After the load dropped, at about midnight, the Corliss units were put on the line, but the valves acted queerly and would not drop. The night shift were put to all kinds of trouble, but the chief was a man of experience. His duty was to keep juice on the line twenty-four hours per day, seven days per week, and he was equal to it.

He simply introduced a little jet of water on the Corliss side of the steam main, and the engines pulled their load as formerly. Mechanical engineers told how to remedy the trouble and salesmen gave advice, but the chief just kept the juice flowing, also the little jet jetting.

C. W. Peter.

New York City.

Boiler-Tube Failures

S. B. Applebaum, in the Sept. 16 issue of *Power*, says: "By changing from the common name of 'boiler compound' to the more fancy term, 'treatment,' and using the vague description, 'having a caustic base,' Mr. Weaver feels reassured." In reply I would say that I have tried almost every "boiler compound," as well as graphite, with considerable loss of time, patience and boiler tubes. Then I tried mechanical methods alone, and got along all right as long as I had soft spring water containing not more than $4\frac{1}{2}$ grains of scale-forming materials per gallon. When I ran into water containing 22 to 25 grains of solid matter per gallon, I was glad enough to turn the problem over to a concern that had made a practical study of feed-water treatment.

Mr. Applebaum also says that the only real cure is to soften the feed water, and further that a water-softening plant can be so operated that there is no greater excess of "caustic base" left in the water than the amount put into the boiler as compound. Now the truth of the matter is, that the use of softeners even when they are operated ideally does not make it unnecessary to turbine the tubes. We find the large plants turbining their tubes just as the smaller plants; besides, some of the large plants I have in mind have plenty of trouble from an excess of soda, I am sure all engineers, including myself, would welcome that *ideal softener* which would cure all boiler-water troubles.

Warren D. Lewis thinks I am pessimistic regarding tube failures, especially those due to floating scale. It isn't pessimism to face facts. I have seen a great many tubes fail in horizontal water-tube boilers after the boilers had been let down and then fired up again without turbining the bottom rows. I want to emphasize again the necessity of turbining the two bottom rows of tubes *every* time the boiler is shut down. Turbine all the tubes if possible, but be *sure* to clean the two bottom rows.

Mr. Lewis' experience in losing 84 tubes due to neglect of turbining backs up my arguments. I recently cut into some burned tubes with an oxyacetylene torch before they had been removed. In every case I found a patch of hard scale about $\frac{1}{16}$ in. thick inside the tube at the point where it had bagged. This scale had evidently been skipped over by the turbine cleaner.

If turbine cleaners alone will prevent the loss of tubes, no other expense is necessary. If, however, time and facilities for thorough turbining are not available, it is advisable to have the water analyzed and to purchase a treatment or compound suited to the individual conditions. If the plant is large enough, a softener is essential. WALDO WEAVER.

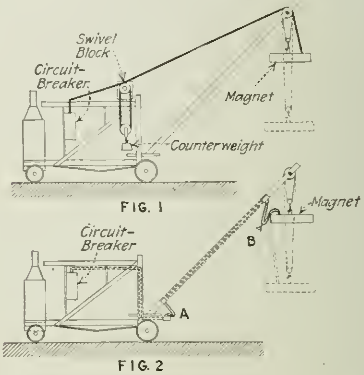
Franklin, Ohio.

Wiring a Lifting Magnet

After considerable trouble and time wasted with our lifting-magnet wiring, we have devised what I believe to be one of the best possible arrangements for carrying the current from the stationary part of the locomotive crane to the magnet. We first tried the method, Fig. 1, of carrying duplex wire from the magnet through a sheave in the end of the boom, to a swivel sheave mounted on top of the crane cab, looping downward through a sheave and counterweight, (to take up the slack in the cable when the magnet is hoisted), thence over a sheave and to the circuit-breaker.

This all looked very fine until put into use; then many kinds of trouble developed. The swivel block, which was expected to turn with the turning of the boom, remained in one position, and this caused the duplex cable to chafe on the iron parts of the block, wearing off the insulation until the cable became grounded. Therefore it was decided to try the scheme shown in Fig. 2, and this has proved highly satisfactory.

Starting at the circuit-breaker, the current is carried by two No. 8 rubber-covered stranded wires run in conduit to the front of the cab, then is dropped down below the level of the bull wheel and carried out three or four inches beyond, where the wires are brought out of the conduit through an approved conduit fitting and looped up to the boom, as shown at *A*, where they again enter conduit and are carried on the boom to the point *B*, located about six or eight feet from the end of the boom, and looped down to the magnet, allowing sufficient slack for free movement up and down.



FIGS. 1 AND 2. TWO METHODS OF WIRING LIFTING MAGNET

This method is better than the old scheme in many ways; it is almost absolutely safe so far as accidental grounds are concerned and it takes only a few minutes to make connections. All that is necessary when through using the magnet is to disconnect the wire and tie the loose ends up to the boom.

Pittsburgh, Penn. WILLIAM H. STEELE.

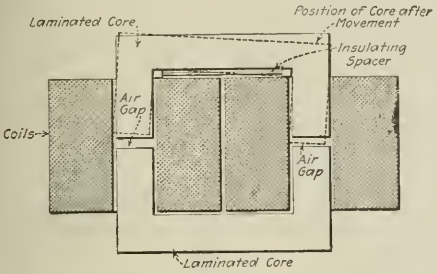
Constant-Current Transformer Failed To Regulate

A constant-current transformer which had recently been installed in a small town to supply a series-tungsten system of street lighting was the cause of considerable trouble and annoyance. The transformer operated on a constant-potential primary circuit and had no moving parts, regulation being effected by a smaller transformer mounted above the main transformer and having a split core, as shown on the diagram. The transformer had been in operation but a short time when the lights on the circuit which it fed began to flicker and grow dim, until the filament barely glowed.

Upon testing, it was found that the secondary current had fallen from its normal value of 6.6 amp. to

4.5 amp. All connections were carefully gone over and checked and were found to be correct. The transformer coils were next taken out of their case, and the normal primary voltage of 2400 volts was applied. Upon the application of voltage a slight movement of the upper core of the regulating transformer was noticed. When the circuit was again broken the core returned to its original position. The regulating transformer was then taken apart and it was found that one of the air gaps was completely closed, thereby decreasing the reluctance of the magnetic circuit and causing the faulty regulation.

No provision had been made for keeping the cores of the regulating transformer apart, except that a small piece of insulating material had been placed between the coils and the upper core. Constant vibration of the core laminations, combined with temperature changes and the natural attraction between the cores while in operation had caused the upper core to sink into the insulation and thereby shorten the air gap. Since the transformer depended upon a constant air gap for its current regulation it was evident that the secondary current would decrease as the air gap was shortened.



ARRANGEMENT OF COILS AND CORE IN REGULATING TRANSFORMER

In order to overcome the trouble, fiber strips of the same dimensions as the core section and of proper thickness were placed between the cores, and then the two cores were clamped together. This construction did not permit of movement in any direction, and after a few adjustments of the fiber strips had been made the transformer was put into operation and no further trouble was experienced. F. H. OBERSCHMIDT.

Milwaukee, Wis.

Method of Banking Fires

The method of banking fires to be followed depends upon the local conditions and the object sought. In making tests for the purpose of comparing various methods it is understood that all connections are to be tight—no water lost, no steam allowed to escape or to enter the boiler from the header. The setting should be air-tight and the damper shut tight so that no air will be drawn through the boiler setting.

Under these conditions I have found that boilers of 150 hp. can be held in reserve with a fairly good bank on the dead plate, with 918 lb. of good coal (13,500 B.t.u.) per 24 hours. This figure is the average of a series of tests conducted during a period of about three months.

The flat bank referred to by a recent correspondent of *Power* as the best method required from 1400 to 1700 lb. of coal per 24 hours and is not at all satisfactory where volatile bituminous coals are used. Banking at the back end of the grates was found to be neither economical nor efficient from a service viewpoint, as the fire would often appear misleading or go out altogether. As it is natural for a fire to burn from the front back, I consider the front bank the best where the boiler must pick up a load quickly.

Where a boiler is on bank continuously, I have found it advisable to cover a large portion of the grate surface with baffle tile or firebrick, maintaining the bank on one side only.

Various expedients can be utilized in many power plants to reduce the cost of banking fires. Some of them are as follows:

Trap the condensate from the steam headers into idle boilers or boilers on bank. Use boilers on bank to operate condenser auxiliaries, steam exciter, etc.

Bleed steam from the header through a reducing valve into the boilers on bank. This will save considerable coal for banking where it is necessary that a given steam pressure be maintained at all times. This plan works out nicely with the second plan when the auxiliaries are operated from boilers on bank during peak load only.

Cover the grates with kindling, placing a strip of oily waste across the front of the grates. Allow hot water from the feed line to leak into the boiler at such times as a surplus of exhaust steam may exist. Blow down occasionally to maintain the proper water level in the gage glass.

Install live-steam heater coils in the drums of boilers having fires kindled ready to light. Install turboblowers on all boilers for the purpose of increasing the capacity. This will usually make it unnecessary to bank boilers for peak loads. Personally, I prefer this plan in conjunction with such other methods as the local conditions will permit or make necessary.

Bypass a portion of the feed water through such boilers as may be needed quickly, the surplus being returned to the feed-water heater. This is an excellent plan where plenty of exhaust steam is available. This plan can be worked out by running the feed pump at a speed that will supply a little more than the normal quantity of water evaporated by the boilers, the surplus being bypassed into the idle boilers. When the water gets too high in the gage-glass of the boilers fired, the pump is not slowed down, but of course judgment must be exercised in opening the valve to the idle boilers or else the feed pump will be speeded up to such an extent that the heater will be pumped dry or else the pump will run away or overspeed.

A good way to overcome this difficulty is to install either a relief valve for this purpose or a small-sized valve piped around the feed valve. The relief valve should also be piped around the regular feed valve with a globe valve in the bypass for shutting off when boiler is in operation.

Fuel oil and natural gas have been used to steam boilers up quickly. This should prove a profitable investment where the load is erratic or variable or in plants where such elaboration would be justified.

Forethought and study along this line have been responsible in great part in producing a better and cheaper service than that offered by the central station. WALDO WEAVER.

Franklin, Ohio.

Live Versus Exhaust Steam for Heating

On page 988 of the June 24 issue of *Power*, James E. Noble discusses the important subject of "Live Versus Exhaust Steam for Heating." This particular subject has been picked to pieces many times, and usually the representatives of central stations have tried to convince manufacturers, hotel owners, etc., that theirs is the cheaper method of obtaining power as compared with that of operating one's own plant. Wherever a goodly percentage of the exhaust steam may be used for heating, for washing or manufacturing purposes, it is considerably cheaper to generate one's own power and utilize the exhaust. Many good plants have been thrown out because the owners listened to the talk and swallowed the figures presented by the central-station men without giving their own engineer a chance to represent his side of the question on equal grounds with the other fellow; and later these same plant owners have found they were buying from 50 to 90 per cent. as much fuel as before and paying a good round figure for current besides. The funny part of it is that few if any of these people have ever admitted the fact or have gone back to what they realize was the cheaper method.

But there looms up another side of the question which is really the most serious part of it. There is one reason, of more weight than all the rest, which gives the glib-tongued central-station agent the advantage, and that is *ignorance* on the part of the engineer, when he does not know how to operate a plant to the best advantage; and the worst and the most discouraging of all is ignorance of the plant owner of the real interest a good engineer takes in his plant, and of not knowing the merits of a really economical proposition when it is put up to him by his engineer. The stubbornness that these men display is due to ignorance.

Let us consider for example, textile mills, where practically all the exhaust may be used for bleaching and dyeing and for heating water for various purposes, and also in the colder months for heating the mill. In such cases it would be decidedly foolish to discard a half-decent power plant and use live steam for all these purposes.

The plant I am operating became overloaded a few years ago and a few small motors were installed to help out. When I came here I showed them a friction load of 246 hp., the entire load carried by the engine being 565 hp. They saw the light, and the first thing done was to have the shafting aligned, which saved nearly 40 hp. on the friction load, and now they are going to install a large alternating-current generator and practically motorize the factory, which will cut out from 60 to 75 per cent. of the remaining friction load and the belts which will be taken out will go a long way toward paying for the motors.

How much better it would be if manufacturers would let their engineers do some of their thinking for them regarding the power question, and do the same thing that we are doing here rather than to trust everything to people who have power to sell. No doubt, in nine cases out of ten, if the amount of money expended in changing a mill over purchased power was used to put in shape the plant which they already have, it would return more than double the interest on the investment; and where, as I have stated, there is plenty of use for the exhaust steam there is no reasonable argument in favor of purchased power.

I have proved to my own satisfaction, by actual test in a plant I was operating, that our coal consumption was only 10 per cent. greater when we were running the engine and using exhaust steam than when we had plenty of water power and were using live steam at reduced pressure.

Every practical engineer must know the advantage of using reducing valves for every purpose where it is possible, therefore it does not seem necessary to consider the use of direct live steam, for the cases are few where it is necessary or advisable. As to using live steam at reduced pressure where the exhaust is insufficient, it is quite true that there are many places where this is done to good advantage, and there are still many places where either or both may be substituted for direct live steam at a great saving by the proper installation of pipe of sufficient size to convey the increased volume of steam at the lower pressure.

I am positive that in a plant where conditions were anything like normal, one could not expect to use as little fuel while using exhaust steam for heating as when using live steam, even when the supply is just adequate to maintain the desired pressure on the heating system. It is evident to me that the difference in the temperature of the live steam, when used in the system, and that of the exhaust would be the basis upon which to calculate the extra amount of fuel to be used while using the exhaust if the same number of heat units are to be given off from the heating coils at a given pressure. L. M. Reed.

Webster, Mass.

Are Operating Engineers Consulted?

How is it that manufacturing concerns, etc., when planning on building a power plant, always go to an architect and a consulting engineer regarding the design of the building and the selection of the apparatus, but never ask an operating engineer into the conference, although he has had a vast experience in practical operation?

After the plant is completed, the engineer is hired and is expected to maintain and keep in operation what they have put in. Is it not a fact, however, that no sooner does the operating engineer assume charge than he finds that there are blunders, some of which cannot be overcome without remodeling the plant, and which might have been avoided had an operating man been consulted?

What do operating engineers think of this subject?

Minneapolis, Minn. L. M. Braten.

Girth Seams in Return-Tubular Boiler

Several letters have recently appeared in *Power* stating that trouble in return-tubular boilers having one-piece fire sheets is due to the absence of the supporting action of the circumferential seams. These girth seams were assumed to act as hoops on the boiler and give it additional strength.

I do not agree with this contention. A boiler would be so badly distorted as to be useless before the restraining effect of the girth seams would come into action. When a boiler explodes, it usually gives way at some point where grooving or corrosion has weakened the plate. In such a case the hoop action of the girth seams would be of no value. D. F. Grahame.

Ottawa, Ont., Canada.

Peculiar Pump Test Results

Much has been written about the design and characteristics of centrifugal pumps, and yet, while testing, problems manifest themselves that cause observers to sit up and take notice. During the last year I have tested over fifty pumps in the plants of various manufacturers throughout the East, one of which led to interesting observations.

The 10-in. pump to be tested was to operate at 865 r.p.m., at a 25-ft. head and to deliver 2400 gal. per min. There was no discharge nozzle sufficiently large to accommodate the capacity of the pump, and consequently the head could not be brought low enough to come within the requirements. The friction in the pump, valves and piping consumed the major portion of the head.

It was then suggested that a Y-connection be used, a manometer or gage inserted at each discharge nozzle and the readings combined as though water was delivered from two pumps. As there was no such Y at the plant and since the pump was urgently needed, it was decided to utilize a manifold that had been procured for some other purpose. This manifold was set up as shown in the illustration, and blanked off at point A. Elbow B and pipe C were not used at this time. When the water was delivered through the pipes and nozzles D and E, the readings of the gages were combined to give the total gallons per minute delivered, but to our surprise the readings of the head vs. capacity, calculated, gave an increase of head with an increase of capacity, as per the following data:

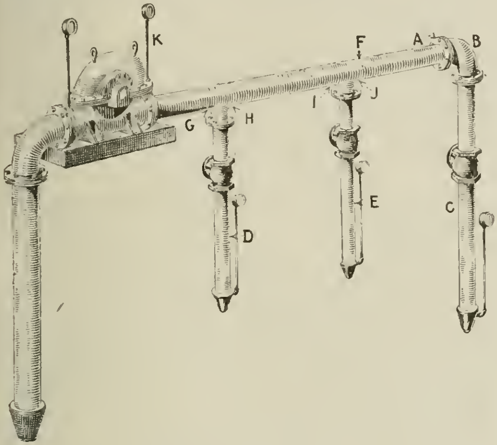


DIAGRAM OF PUMP PIPING

Head	G.P.M.	Head	G.P.M.
29.23	0	26.2	2080
22.65	2520	22.0	2629
23.60	2550	22.4	2885
25.85	2880	22.65	2995

Since no well-behaved pump should go on such a rampage, it was up to us to determine how it got that way, and this is our solution:

One portion of the water discharged through pipe and nozzle D and the other portion of the water that finally discharged through valve and nozzle E was first split up into two parts—one part to discharge direct through the pipe and nozzle E and the other part to impinge against the blank flange A. The mass of water immediately behind that impinging on the flange acts to dislodge the previous impinging water, downward and backward, with a rotary motion, setting up eddy currents from A to F and then to straighten out in order so that it can be carried through the discharge pipe E with the water that discharges in a direct line from the discharge head. Small amounts of eddy current are likewise set up at the points G, H, I and J in the manifold.

As the valves of D and E are opened to admit more water, the pump being run at constant speed, the mass of water impinging upon the blank flange is increased, thereby increasing the force of the impact as well as the eddy currents wherever formed. As this impact increases, it requires more power to overcome it (AF equals dMA) and consequently the readings of the pressure gage at the discharge side K of the pump will register increase with the increase of capacity, or in other words, set up pressure readings that are required not only to deliver the water, but also to overcome the impact and the eddy currents.

It was decided to remove the pipe and nozzle E, blank off the opening to E and discharge through the pipe and nozzle D and elbow B and nozzle C. This eliminated our trouble and with slight corrections for eddy currents completed a satisfactory test.

New York City. S. ROSENBERG.

Superheated Steam for Reciprocating Engines

In regard to superheated steam for reciprocating engines, we may safely say that there is no one at all versed in steam engineering, who is not ready to admit that from a purely theoretical standpoint superheat is of great benefit in a reciprocating engine and that it is of even greater advantage in this class of prime mover than in turbines. It is, however, when we turn from theoretical considerations and enter the field of practical operation, that we sometimes come face to face with problems and conditions that often make it hard to decide whether superheat is of any advantage in that particular plant.

It is my opinion that with the right cylinder oil a total steam temperature up to but not exceeding 500 deg. F. should not give any lubricating trouble. But sometimes things go wrong, especially in plants where it is necessary to employ chemical reagents to soften the feed water. Here the concentration in the boilers may get too high, the water may accidentally get high, or the safety valve may blow. Any one of these conditions is liable to start priming, and when this takes place the water carried over in the superheater is evaporated, leaving the soda and sediment it contained in the form of a dry, inpalpable powder which the steam picks up and carries over into the engine, thus destroying lubrication and setting up an abrasive action which quickly wears out the piston rings and the cylinders.

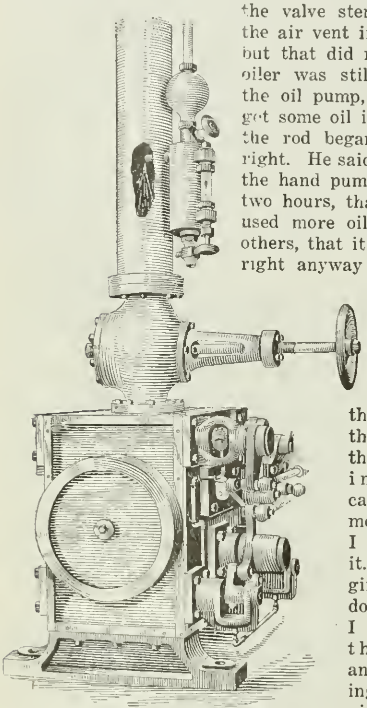
It has been my experience that this excessive wear in the high-pressure cylinder has been the one great drawback to using superheated steam in reciprocating engines in power plants in which there is no surface condenser.

The obvious remedy would seem to be to install surface condensers in all plants using superheated steam. CHARLES L. ANDERSEN.

East Chicago, Ind.

Changed the Lubricator Piping

When a drop of oil disappears up the sight glass of a lubricator, it does not indicate that the oil goes where it is needed, and the engineer must decide by the running of the engine as to whether it is being properly lubricated or not. I once took a night job where a 50-hp. engine ran a steam laundry. The engine was installed in a room separate from the main engine room, and no one bothered much with it so long as it ran. The first night one of the laundry hands complained about the power. The oiler ran to the laundry engine and started to use the hand oil-force pump. The crank-end dashpot would not drop. I loosened the gland nuts on the valve stem and opened the air vent in the dashpot, but that did no good. The oiler was still working on the oil pump, and after he got some oil in the cylinder the rod began to drop all right. He said he had to use the hand pump about every two hours, that this engine used more oil than all the others, that it never worked right anyway and that the piston-rod packing had to be renewed frequently. I reported to the chief the next night that I thought the trouble was in the lubricator. He told me to see what I could do with it. After the engine was shut down that night, I disconnected the lubricator and upon screwing out the ½-in. nipple in the steam pipe where the oil entered above the throttle valve, I found only two threads holding it in place. Of course the oil was running down on the inside of the pipe and not mixing with the steam, so that the head-end of the cylinder was getting practically all the oil and the crank end none. I got a bushing, reduced it from ½ to ⅛ in. and screwed a ⅛-in. nipple through it long enough to reach to the center of the inside of the pipe above the throttle valve so that the oil could always mix with the steam going to the cylinder.



CHANGED LUBRICATOR OUTLET

The lubricator was connected and the packing on the piston rod renewed. The engine then ran all right and it was not necessary to use the force pump. The piston rod was turned true, the packing renewed on the four valve stems and the trouble was ended. The lubricator connections on the other engines were also changed.

New York City. PATRICK MALLOY.

Boiler Tubes Burned Out

The following recounts the particulars of the burning out of tubes under the drum and on the opposite side from which the feed water enters the boiler.

The boiler has three drums, 14 tubes high, 21 wide and is rated at 600 hp. We recently installed six boilers of this type and experienced a great deal of trouble with burning out of the tubes connecting with No. 3 drum.

When I called on our chief chemist to look at the condition of No. 3 boiler, in which six tubes were being renewed, he requested a sample of water from each drum while the boiler was running. I suggested that we drill and tap in a ¼-in. pipe in the bottom of the header, directly under the middle of each drum. This was carried out by tapping the header caps opposite the bottom row of tubes and carrying the pipes out through the front doors so that samples could be taken while the boiler was in operation. The caps tapped were Nos. 4, 11 and 18 on the bottom row. The sample thus obtained gave us the exact condition of the water at the point of trouble.

The boiler was filled with water with a salinity of 6 in 100,000 parts, put under pressure and cut in on the line. After it had been in service for 22 hours, a salinity test was made. Another one was made after 41 hours' run. The combined results appear in the following table:

SALINITY, PARTS PER 100,000

	After 22 Hours' Run	After 41 Hours' Run
Under drum No. 1 *....	19.0	21.3
Under drum No. 2	22.5	44.5
Under drum No. 3	110.0	170.0

* Drum No. 1 is the one nearest the feed-water regulating valve.

As can be readily seen, the condition in No. 1 drum, as regards salinity, changed but little between tests. In No. 2 the amount of the first test is doubled in the second. The reason No. 3 drum did not increase between tests as did No. 2 was because it was blown twice to the others' once. Up to this time we had blown all three at the same time.

This test shows that the largest portion of the feed water entered No. 1 drum. The rest went to drum No. 2, and No. 3 got its supply entirely from the mud drum, as indicated by the concentration of salt and the extreme cloudiness of the water which was taken from it.

Since then I have made daily salinity tests on each drum of No. 3 B. & W. boiler.

By setting the check valve on No. 1 drum at ¼ turn open, No. 2 at ¾ turn open, and No. 3 wide open, the feed-water distribution has been nearly equal through the whole boiler. This was not done at one step; I went very slowly, first setting the valve on No. 1 drum only at two turns open and so on until they were set as stated. I raised the feed pressure for safety, but otherwise had no trouble keeping water in the boiler, even when it was running at 60 per cent. overload.

No tubes have been lost since the test pipes were put on this boiler, so I am putting test pipes on all the boilers as soon as they are down. The builders are working on a different feed-pipe arrangement that will insure equal feed-water distribution.

I should like to hear from someone else through the columns of *Power* on tube troubles and their prevention.

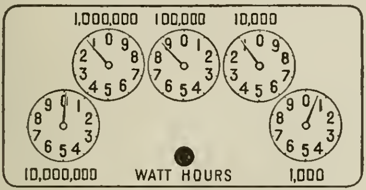
Crockett, Calif. C. A. NELSON.

What Does the Meter Read?

The dials of A. A. Frederick's watt-hour meter, reproduced here from the Sept. 2 issue of *Power*, are indeed suffering a bad case of misplaced pointers. This is the cause of many errors being made, even by the most experienced of meter readers, and therefore great care should be exercised in reading such meters, and the results should always be checked.

Misplacing of the pointers is the result of two causes, one of which is that there is always a certain amount of backlash or slack in the gears of the recording train, which, when it is taken up by the rotation of the gears, which progresses from right to left, the gear ratio usually being 10 to 1, causes the pointer to the left to lag, or read behind the figure which it should indicate. The other cause is the actual misplacing of the pointer on the shaft, in which case the pointer may be behind or ahead of its proper position.

To read this meter correctly and to be sure the reading is right, the record of previous readings should be available to be used as a check. The two lowest-reading dials seem to be in about their proper position with respect to each other. Therefore, the 1000 dial may be read as 0, and since the pointer of this dial is to the right of 0, the next dial to the left will be read as 1, making the reading so far 10, or equal to one complete revolution of the lowest reading dial, or 1000 watt-hours. Coming to the third, or 100,000, dial we get to the place where our previous records become very valuable in assisting to read correctly. Since the second lowest dial pointer is on 1, we know that the third dial pointer should register very close to one of the numbers, and as it is nearest to 9, it may safely be assumed that, owing to excessive slack in the gears or a combination of the two causes of this trouble that 9 is the correct figure, making the reading now 910. The fourth dial has passed 1, but as the third dial has not as yet made a complete revolution it is evident this dial should still be read as 0. This conclusion is strengthened by the position of the fifth dial, which has moved but slightly to the right of 0 and not enough to indicate that the fourth dial should be near the 2, which position it must be in to be read as 1, considering the position of the third, or 100,000, dial.



WATT-HOUR METER DIALS

Assuming the foregoing conclusions to be correct, this meter should be read 0,091,000 watt-hours, or if it is desired to split the divisions of the lowest reading dial, 0,091,060 approximately, **George E. Lyons.**

Woodhaven, N. Y.

Referring to "What Does the Meter Read," in the Sept. 2 issue of *Power*, I would give the following solution:

The 1,000 hand has not reached 1, so I would put the reading of this dial at 0. The 1000 hand having passed 0 would indicate that the 10,000 hand has just passed a number, and as this hand points nearly to one, the reading of this dial would be 1. The 10,000 hand reading 1 would indicate that the 100,000 hand should be slightly by some number. The hand points nearest to 9, so I would put the reading of this dial as 9. The fact that the 100,000 dial reads 9 would indicate that the hand on the 1,000,000 dial should be very nearly to but has not yet reached some number. This hand points a little beyond 1, but should not have reached 1 yet. This dial should then be read 0. The 1,000,000 dial reading less than 1 would indicate that the 10,000,000 hand should be just by some number. As this hand points slightly by 0, this dial reading is taken as 0.

My interpretation of this meter reading is 0091000 or 91,000 watt-hours. It is apparent that the hands on the 100,000 and 1,000,000 dials are misplaced and should be corrected, as it would be very misleading to a meter reader to have them as shown.

Montour Falls, N. Y. **Frank L. Schlick.**

Following the rule for meter reading, the solution of "What Does the Meter Read?" *Power*, Sept. 2, is quite simple.

Since the first, or right-hand, dial has made a complete revolution, the second dial will be at a figure, in this case, 1, and since the second dial had just completed a revolution and passed to the first figure, the third or center dial must be at 9 regardless of the position of the hand. The third hand has not completed the revolution, therefore, the fourth dial must still be read 0, the fifth or left-hand dial is still at 0, so the complete correct reading is 91,000 watt-hours.

In reading dials like this all that is necessary is to remember that the first, or right-hand, dial is fixed to the metering mechanism so must be correct, and that if there is backlash in the gears the other will drop to the lower side of the proper position to the limit of the backlash. **Allan A. Blanchard,**

Chief Engineer, Ringwood Co.

Ringwood Manor, N. J.

I notice in the Sept. 2 issue of *Power* a meter dial to be read. It is evident that there is a hand displacement on this meter. Lettering the dials *A*, *B*, *C*, *D* and *E*, *A* being the extreme left-hand dial and *E* the right-hand dial, dial *E* would be read 0, dial *D* 1, dial *C* should be slightly past some index number, where now it is two-thirds distance between 8 and 9. Dial *B* is also misplaced. Hand *B* should have traveled nine-tenths the distance between 0 and 1. If I were to read this meter in regular routine work, I would consider this reading 91,000 watt-hours and then consult previous readings to make sure I had the hand displacement properly accounted for.

Mechanics Falls, Me. **Albion C. Barker.**

[The foregoing letters give the correct reading and the method of reading the watt-hour meter dials published in Sept. 2 issue of *Power*. Other answers were submitted by L. W. Wyss, 91,060; Leon L. Pollard, 91,000; Earl Pagett, 91,075; George Leverance, 91,000; Frank Wenger, 1,910,000; Henry Mulford, 121,000; E. A. Quinter, 181,070; C. M. Hamann, 0,091,100; H. G. Brinckerhoff, 01,810; George B. Lampkin, 1,910,000; D. G. Simmons, 01,010; W. F. Condon, 1,810,000; Geo. H. Boren, 91,000. It is regretted that space would not permit publishing the solutions of all those sending in correct answers.—Editor.]

Installation and Use of Air Chambers

In *Power* for Aug. 5, 1919, page 209, is an article on the "Installation and Use of Air Chambers," by H. D. Fisher; also the July 8, 1913, issue contained an article on the same subject, entitled "Functions and Design of Air Chambers," by the writer. In recognition of certain important principles and requirements the two articles are in agreement.

It is mutually established that: pulsations in flow in the pipe line cause too high readings in the venturi, orifice and pitot types of meters; the only practical method of overcoming this difficulty from pulsations is to absorb them by means of air chambers; the function of the air chamber is to store up energy during the forward stroke of the feed pump and give it out again when the pump is reversing, thus "smoothing out" the flow; the flow of the water must be artificially directed against the air cushion in the chamber; the air chamber should be fitted with a gage-glass and proper means for charging the chamber with air should be provided.

In addition the earlier article points out that air chambers on reciprocating pumps are often valueless, owing to improper design or operation; that in boiler plants, pulsations in flow usually are accompanied by destructive water-hammer on pump parts, boiler-check valves, main valves, gaskets, etc., and that it is highly important to carry a pressure in the feed line in excess of the boiler pressure to enable the air chamber to perform properly its function of absorbing and giving out energy.

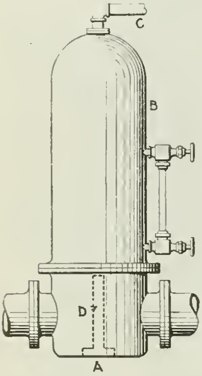


FIG. 1. AIR CHAMBER WITH SPECIAL CASTING

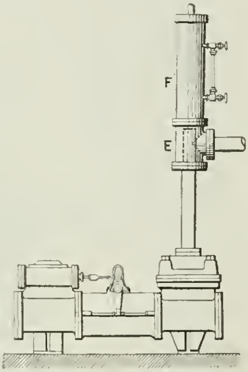


FIG. 2. AIR CHAMBER PLACED ON A TEE

The two articles disagree materially in the design of the air chambers. Mr. Fisher claims that best results are obtained by making the air chamber of the same size pipe as the feed line and obtaining the necessary volume by increasing its length and that if it is made either larger or smaller, there will be an abrupt change of velocity in the water entering or leaving the air chamber, with a corresponding loss of energy and efficiency.

In my article two general designs were shown: Quoting from the article:

> If it is absolutely necessary to place the air chamber in the main line, a special casting *A*, Fig. 1, should be made, containing a vertical partition several inches higher than the main pipe connections. On the top of this special casting may be mounted another casting *B*, of the shape illustrated, or if preferred, this top piece can be made up of pipe fittings. A gage-glass should be attached to the lower end of *B*. There should also be a connection *C* of, say, ¼-in. pipe, for charging the air chamber when the gage-glass shows that the air has been partly absorbed. It will be noticed that the course of the water is directed by the baffle *D* against the air space, and then has to change its direction again before leaving the chamber.
>
> It is usually possible, however, to locate the air chamber on a tee, as illustrated in Fig. 2. This is a less expensive and fully as effective arrangement. All the fittings may be made up from stock pipe and specials. It is essential that the discharge pipe from the pump be carried above the outlet from the tee, as shown at *E*, so that none of the water can pass the tee without coming in contact with the air space in chamber *F*. This bypassing materially reduces the effectiveness of the air chamber.

In both illustrations it will be noted that the air chambers are made considerably larger than the feed line, and the following dimensions were recommended:

Size of Discharge Line, In.	Inside Diameter of Air Chamber, In.	Total Height of of Air Chamber, Ft.
2	8	2
2½	8	2½
3	10	3
4	10	4
5	12	5
6	16	6

Accompanying this table is this explanation:

> With the exception of the single-cylinder, single-acting, direct-connected pump, which is not often found in power plants and which is diminishing in favor, the dimensions of the air chamber should be sufficient to provide an air space from five to six times the displacement of one pump plunger. The size of discharge lines bears a fairly constant ratio to pump capacity, and satisfactory results have been obtained from air chambers of the above dimensions.
>
> It will be noticed that the height in feet corresponds to the diameter of the line in inches. If there is not headroom enough, the chamber may be reduced in height and increased in diameter, retaining the same volume and making the neck as large as the second column of the table.

Some eight years of experience with air chambers have thoroughly confirmed the recommendations of the original article. In most instances the proof of the effectiveness of the air chamber has been visibly demonstrated by a mercury manometer attached to a venturi meter tube in the food line. It is regrettable that more data on this important subject have not been published. Numerous readers of *Power* undoubtedly could add valuable comments from their experience, and it is hoped that this discussion will bring out such contributions.

Providence, R. I. CHARLES G. RICHARDSON

Explosion of Sanitary Process Apparatus

This letter reports an investigation of the explosion of one of the portable sterilizers in the sanitary process plant of an Eastern camp. Each of these sterilizers, which are used to delouse the clothes of soldiers returning from over seas, consists of a vertical boiler designed for 120 lb. pressure and a steam-jacketed sterilizing chamber, all mounted on a truck. A steam ejector is provided to produce a vacuum in the sterilizer. Proper reducing valves, gages, etc., are supplied for regulation and operation. The door of the sterilizer is mounted on crane trunnions and is made tight by means of radial arms which lock into the flanged frame of the chamber body.

The manufacturer's instruction for operation are substantially as follows:

A constant steam pressure of from 45 to 60 lb. is maintained in the steam jacket. After the clothes are placed in the sterilizing chamber, a vacuum of 15 in. of mercury is produced by the ejector to remove as much air as possible from the clothes. Then steam is admitted until the pressure in the chamber reaches 15 lb. gage. This maximum pressure is controlled by a reducing valve. The steam is then shut off, the pressure relieved through an outlet valve and the vacuum restored. The entire process should not last more than fifteen minutes.

After the explosion an investigation showed that although these units had been in continuous operation for about six months, the boilers, fittings, valves, etc, had never been cleaned or inspected. The try-cocks, gage-glass fittings and blowoff valves were stuck fast with scale. The reducing valves, gages and control valves were also more or less obstructed with scale so that they could not operate properly. The vacuum gage showed a negative reading, while the pressure gage on the jacket read 30 lb. when they were both open to the atmosphere.

The story of the accident appears to be as follows:

On opening the steam valves the operator could not get the desired pressure, and after opening the main valve wide he opened the bypass around the reducing valve. One of two things happened. Either the steam pipe, being plugged with scale, was suddenly cleaned out by the high-pressure steam coming through the bypass, or the pressure had gradually built up owing to the leaky condition of the reducing valve, but did not show on the defective gage. The resulting pressure buckled the door and bent the locking arms so that the door was blown off.

The real cause of the trouble was obviously ignorant and careless operation without proper supervision. As a precaution against future trouble instructions were given requiring strict compliance with the manufacturer's operating instructions, monthly inspection of all parts, fittings, etc., especially reducing valve, and thorough monthly cleaning of the boilers. It was also suggested that steam be supplied from a central boiler plant where proper boilers, vacuum pumps, etc., might be maintained under the care of skilled operators.

New York City. S. ROSENBERG.

"Horrible Examples" in Steam Plants

At one time it was the practice of reform workers when preaching to have a "horrible example" on the platform as a danger sign for their audience. Perhaps some efficiency converts could be made by bringing to the attention of *Power* readers some of the "horrible examples" in steam plants, of which there are many.

Awhile ago I assumed the responsibility of the maintenance and operation of one of these "horrible examples." This plant has six boilers with a total of 1840 hp. Nos. 1, 2 and 3 boilers are served by a 7-ft. diameter, 130-ft. high steel stack. The weight of this stack and heavy ⅜-in. steel breeching is borne by the settings of Nos. 1 and 2 boilers. Each of the other settings support a single stack and breeching. On account of the swaying of the stacks, it is impossible to keep the boiler settings tight—in fact, it is difficult to keep them from collapsing.

The coal burned is 30 per cent. volatile matter and averages about 13,500 B.t.u. It is hand-fired in furnaces where the ratio of combustion space in cubic feet to square feet of grate surface is not more than 2½ to 1, and it is burned at the rate of 25 lb. per square foot of grate surface per hour. Nos. 1 and 2 boilers have but 39 sq.ft. of heating surface to each square foot of grate surface, and the stack temperatures approach 800 deg. F. All dampers are kept wide open for all loads and for no-load conditions. The condition of the furnace fronts is such that the fireman examines his fire, and might also coal up, without opening the fire-doors.

A steam header 75 ft. long is supported on iron posts along the boiler fronts with each boiler connection made with a valve and straight nipple. From the center of the boiler flange to the center of the header is but 52 in., with no provision for changes of expansion of the header. Of course the joints all leak, and I wonder that some have not torn loose. The steam lines are excessively large, with much uncovered surface, and all steam traps discharge outdoors.

It was the practice of the firemen when cleaning fires to push the fire back and then turn on the hose and drench the front of the fire. Result, a mason and a helper were kept hustling all the time. We have an open heater that is apparently very dirty, with the holes in the pans sealed over, as it exhausts a considerable quantity of steam when the temperature reaches 150 deg. F.

We expect, however, in less than six months to improve some of these conditions. A new chimney is already erected and the contract made for installing new breechings. An automatically operated main damper and uptake dampers for hand control will be provided. The settings are to be rebuilt and the boilers raised to give greater combustion space. The grate surface will be properly proportioned and new furnace fronts installed. The discharge of steam traps will be recovered and steam leaks and radiation losses eliminated as far as possible. We have on hand new nonreturn stop valves to install in the new connections between the steam header and the boilers.

With the changes mentioned and equipment for weighing coal, metering water, making proximate coal analysis and instruments to indicate and record boiler and furnace performance, we are anticipating a large increase in plant efficiency.

The nonreturn stop valves for these boilers were on the premises when I took charge and were ordered to conform in size to the boiler flanges, which are all 8-in. extra-heavy pattern. One boiler is of 480 hp. capacity, one 364, one 316, one 240 hp. and two are 220 hp. each. Steam pressure is carried at about 150 lb. gage.

As a nonreturn valve gives a longer and more satisfactory service with a velocity of steam flow above 5000 ft. per min., I wrote the manufacturer of the valves explaining that the steam velocity through these valves on the smaller boilers would be less than 1100 ft. per min. They agreed with me and are arranging to exchange the valves for smaller ones and credit us with the difference in price, which is more than 50 per cent. of the original bill. The valves we have decided on are smaller than good practice might seem to indicate.

A discussion by *Power* readers on the advantages of high steam velocities and the limit for good practice for different classes of work should prove of interest to many.

Our boiler-feed line is, I think, also too small, which requires a pressure at the pump considerably in excess of the boiler pressure.

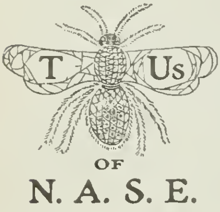
For feeding 60,000 lb. of water per hour at 212 deg. F., what size of pipe is required? DAVID CRAFT.

Auburn, N. Y.

B. T. U.'s No. 1 of the N. A. S. E.

What are the B. T. U.'s of the N. A. S. E.?

They are the best friends of that organization, their main object being to induce N. A. S. E. members to attend and take active part in their meetings, to help reorganize weak associations that have dropped out or are liable to drop out of the state association. They are not, however, to interfere in any way with the N. A. S. E., but will encourage its members to be known at their meetings. The emblem is shown herewith.



THE EMBLEM

The B. T. U.'s will make their meetings attractive and interesting by having drills with the degree that will impress the candidate as to his obligation, also there will be uniformed drills for street parades. They will try to make the N. A. S. E. better known in the business world.

There is only one B. T. U.'s association in the country, and it is in its infancy, but it promises big returns. They invite any and all N. A. S. E. associations to inquire of Earl C. Olin, 490 Court St., Rochester, N. Y., for details and information, regarding its mission.

Rochester, N. Y. EARL C. OLIN.

Slow Engine Speed and Condensation

Referring to the discussion (*Power*, July 15, page 116; Aug. 19, page 311) regarding slow engine speed and condensation, I am thoroughly convinced that every power plant has to have a different set of rules to work by and that the system and arrangement of installing and operating machinery that will work well in one plant will be a failure in another. The circumstances surrounding the case is the vital point, and the obstacles, such as they are, have got to be overcome. The method employed may not be exactly correct from a mechanical point of view, but possibly no other arrangement would meet the necessary requirements, therefore we have to attack the difficulties in the way that is most suitable for the trouble in question.

Going back to the question of mechanical stokers driven by steam engines, which means a varying speed according to the power consumed, there is a normal speed for these engines to run, although there are times when the speed is either far above or below it, and occasionally for a short interval a complete stop, then a sudden start up at, for instance, the normal speed, and then the engine gets a dose of water which causes all kinds of trouble.

Steam traps and separators are fine things and save thousands of dollars annually in various ways, but in the case of steam pipes which convey steam to stoker engines, etc., I think that they are unnecessary. Such engines are usually installed on the boiler front or setting, and it is simple and easy to allow a 6-in. or a 1-ft. fall in the steam line from the boiler to the engine, the low end being at the boiler. If the engine is stopped for five minutes or even one hour, most of the condensed water from the steam, as fast as it accumulates, is gradually draining back into the boiler or heater, thereby obviating the necessity of mechanical devices. H. W. ROSE.

Brenham, Tex.

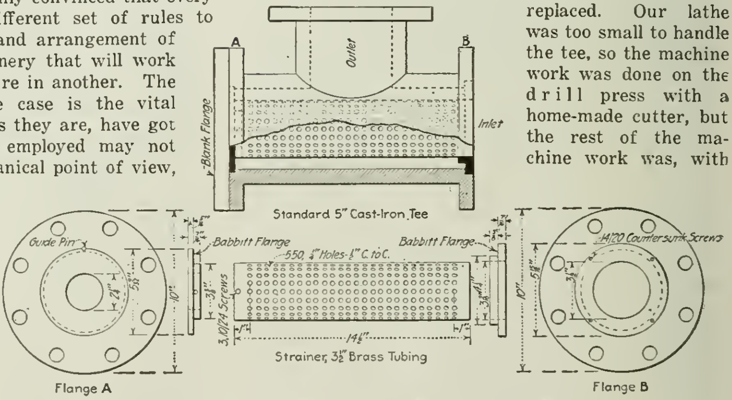
Homemade Pump-Line Strainer

The strainer, made as illustrated, was placed in the water supply line for a turbine air pump serving a 2500-kw. turbine. The original strainer (which was left in the line) consists of two baskets, which are lifted out of the strainer body when cleaned.

One day we lost the vacuum on account of trouble with the air pump. This was found to be caused by a cinder lodging in one of the nozzles of the pump. We concluded that in some manner the cinder had dropped out of the basket while being cleaned, and in that way entered the pump. To avoid future trouble along the same lines we made and installed a strainer of our own close to the pump, and between the pump and the other strainer.

The supply line is 4 in. A 5-in. flange was bored out to fit the 4-in. pipe and to which the flange *B* of the tee was bolted. The outlet flange was fixed in the same manner. The hole in the babbitt flange fastened into the flange *B*, is tapered so as to make it easy to insert the strainer. The babbitt flange in flange *A* is fastened to the strainer by means of three machine screws, and has a hole in it to make it easy to remove and to steady the strainer when being replaced. Our lathe was too small to handle the tee, so the machine work was done on the drill press with a home-made cutter, but the rest of the machine work was, with the exception of drilling of the holes, done on the lathe. W. H. MOORE.

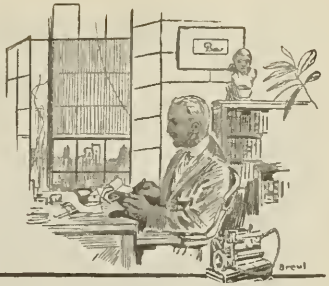
Paterson, N. J.



DETAIL OF HOME-MADE PUMP-LINE STRAINER

In every boiler room there should be one man to supervise the work of the others. His duty is to see that the necessary coal is delivered to the stokers, that the water level is properly maintained in the boilers, that each man does his fair share of work, and to instruct them how to obtain the most from the fuel fed to the furnace.

INQUIRIES OF GENERAL INTEREST



Hydrostatic Test Pressure for Boiler—If a boiler safety valve is to be set to blow at 250 lb. gage pressure, what should be the hydrostatic test pressure? F. S.

A boiler should be subjected to a hydrostatic test of one and one-half times the maximum allowable working pressure, and the test pressure should be under proper control so that the required test pressure should not be exceeded by more than 6 per cent. If the safety valve is to be set to blow at 250 lb., the boiler should be subjected to a hydrostatic test of $1\frac{1}{2} \times 250 = 375$ lb. per square inch.

Critical Speed of Shaft—What is meant by the critical speed of a shaft? R. E. B.

The critical speed is that speed of rotation at which the elastic forces are completely neutralized so that the shaft is incapable of offering any resistance to a deflecting force. This speed is numerically the same as the frequency of vibration that the shaft would have with the same masses mounted on it, if deflected by an external force, while the shaft otherwise is at rest. The axis of rotation rarely passes through the center of gravity, and the "hammering" due to centrifugal deflection is greatest when the r.p.m. are in unison with the number of vibrations.

Use of Glycerin for Hydrostatic Tests—Why is glycerin used in place of water in making hydrostatic tests of castings or forgings that are for high-pressure service, such as recoil cylinders of cannons? E. E. R.

Pine glycerin is rarely if ever used for the purpose, but it mixes readily with water and the viscosity of the mixture renders it easier to hold under high pressures against leakage of joints and packing. Other advantages are that the mixture is much less corrosive of metals than water and the freezing temperature of the mixture is lower than that of water, a 5 per cent. glycerin solution in water having its freezing point at about 10 deg. above, and a 10 per cent. solution at about 10 deg. below zero.

Rotation Direction of Alternator—Does it make any difference which direction a newly installed alternator revolves? Or will the exciter connections to the alternator have to be reversed in case the generator is rotated in a direction opposite from that intended by the manufacturer? The exciter is driven from the alternator. E. G. H.

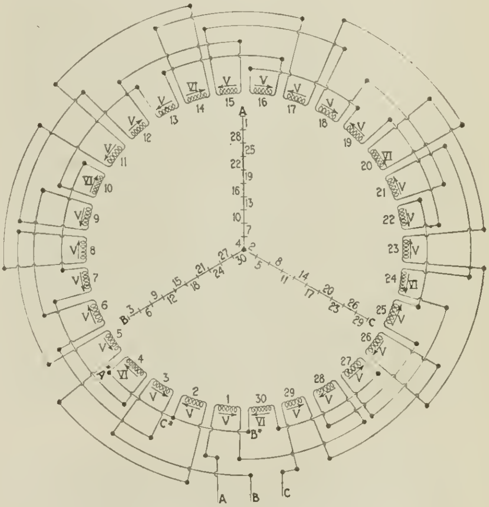
If the machine is operated as a single unit, it will not make any difference in which direction the rotor revolves. If the direction of the exciter is reversed, it will be necessary to cross either its armature or field leads so that the machine will generate. Where the alternator is operated in parallel with other machines care will have to be taken to see that the new machine has the proper phase relation to the bus voltage.

Omission of Counterbores from Duplex Pumps—Why are not the cylinders of a duplex pump counterbored? S. O. R.

The cylinder of a reciprocating engine that is constrained to a uniform length of stroke is counterbored so the piston may override the ends of the main bore and thus prevent the wear from forming shoulders in the bore at each end of the stroke. With a duplex steam pump the absolute length of stroke and portion of the cylinder over which the pistons travel vary with speed, steam pressure, valve setting and chance amount of "lost motion" of the valve gear; there is little likelihood of formation of abrupt shoulders from wear and, for ordinary duplex pumps, there is little or no advantage in counterboring the cylinders.

Uneven Number of Coils in Rotor Phases—In a 40-hp. three-phase wound-rotor motor in which I short-circuited the slip ring and tried starting with a 50-hp. compensator, the motor developed positions where it would not start; in fact, the operation of the motor was so unsatisfactory that operating it under the foregoing conditions was abandoned. The stator has 120 coils grouped in a 10-pole winding, and the rotor has 156 coils connected two phases of 57 coils each and one phase of 42 coils, connected series star. Why is it that there is not $156 \div 3 = 52$ coils in each phase? Has the unbalancing of the winding anything to do with the trouble that the motor developed? M. P.

It is apparent that a mistake has been made in connecting up the windings; two pole-phase groups of 5 coils each being taken out of the phase that has only 42 coils and connected into the two phases that have 57 coils each.



THREE-PHASE SERIES-STAR GROUPING

With 156 coils, in a 10-pole rotor, to give a balanced winding there will be 52 coils per phase, grouped 8 poles of 5 coils each, and 2 poles of 6 coils each; the 6-coil pole-phase groups will have to be distributed as in the figure. The Roman notations indicate the number of coils in each pole-phase group.

There is little doubt that the way the rotor was connected contributed to the unsatisfactory operation of the motor, especially at starting. However, after the motor was started it should have given satisfactory service unless there was some trouble in the stator winding or connecting wires.

Semiannual Hearing of Massachusetts Board of Boiler Rules

THE semiannual hearing of the Massachusetts Board of Boiler Rules was held at the State House, Boston, on Thursday, Nov. 6.

The Hartford Steam Boiler Inspection and Insurance Co. asked that the form of certificate be changed so that it could be filled out on the ordinary typewriter. This could be done without changing the size of the certificate or the frame in which it is preserved, by simply turning it through 90 deg. and making its greater dimension in the direction of its length instead of the width. The only change in the wording suggested was that the date or year in which the boiler was put into service should be recorded, instead of the number of years in service, which latter quantity had to be changed every year, whereas the former would remain the same during the life of the certificate.

Dr. Charles L. Huston, of the Lunkens Steel Co., petitioned that Par. 9, Sec. 4, of Part III, be amended as follows:

PRESENT READING	PROPOSED READING
A horizontal return-tubular, vertical-tubular, or locomotive-type boiler shall not have a continuous longitudinal joint over twelve (12) feet in length.	In horizontal return-tubular boilers with lap joints, no course shall be over twelve feet long. With butt and double-strap construction longitudinal joints of any length may be used, provided the tension-test specimens are so cut from the shell plate that their lengthwise direction is parallel to the circumferential seams of the boiler, and the plates meet the standards prescribed in the specifications for boiler-plate steel.

The causes which led to difficulty with the use of large sheets and long seams some years ago, Dr. Huston said, have been largely removed. At one time it was thought that a superior design had been found in a boiler with a single lower sheet, which avoided the circumferential seam over the fire, and looked promising, but several disastrous failures of boilers so constructed occurred. It is now thought that this may have been due to the fact that the sheet was used lengthwise in the boiler—that is, rolled across the grain—and was not wide enough to get the longitudinal seam up out of the furnace, the trouble being due to overheating at the seam. Plates are now obtainable in widths up to 16 ft., so that objection no longer exists. The fact that the greatest tensile strength is at right angles to the direction in which the plate was last passed through the rolls is of little importance, for in the making of these wide plates a great deal of cross-rolling is done. To get the desired width, the billet is turned and put through the rolls sidewise, so that there is drawing of the material in both directions, and not so much tendency to the formation of a grain or fiber as when the rolling is all lengthwise.

S. F. Jeter, chief engineer of the Hartford Steam Boiler Inspection and Insurance Co., said that the shorter course was stronger, but that the longer course seemed to have compensating advantages.

F. R. Low, editor of *Power,* told of the discussion which has been going on in these columns on the subject, and pointed out that while the objection to the long seam appeared to be founded upon failures in practice, none of these failures have apparently occurred with butt-strap joints. In a contribution now in hand, C. E. Stromeyer, chief engineer of the Manchester, England, Steam Users' Association, says that he prefers long seams.

J. O. Leech, secretary of the Association of American Steel Manufacturers, said that plates that have been cross-rolled show little difference in elongation or bending, in whichever direction the test piece is taken, but with plates that were "universal rolled" the crosswise specimens do not show so much elongation, nor bend so well, as those taken lengthwise of the sheet. He removed from Dr. Huston's petition any appearance of self-interest by explaining that a number of other mills besides the Lunkens were furnishing wide plates.

The Massachusetts Rules require that "each boiler shall be stamped by the builder, in the presence of the inspector, with a serial number and with the style of stamping shown in facsimile previously approved by the Board."

It occasionally happens that the representative of the manufacturer picks up the wrong stamp, or in some way stamps the wrong number upon the boiler. In such a case the Board has insisted that the inspector, and in some cases that both the employee who made the mistake and the inspector, come to Massachusetts and make the correction. This seems to involve unnecessary delay and expense, and the Hartford Steam Boiler Inspection and Insurance Co. petitioned the Board to allow the change to be made by one of its own inspectors upon conviction that an error had been committed, and that the boiler upon which the correction was asked to be made was identical with that covered by the certificate in hand.

The Association of American Steel Manufacturers petitioned:

That the sulphur limit for extra-soft steel should be changed from 0.04 to 0.045.

That Par. 6 in Sec. 1 of Part III be modified as follows, so as to carry out the obvious intent of the paragraph, which is that a deduction of 1 shall be made from the percentage, and not a deduction of 1 per cent. from the elongation:

PRESENT READING	PROPOSED READING
(a) For each increase of ⅛ in. in thickness above ¾ of an inch, a deduction of 1 per cent. shall be made from the specified elongation.	(a) For material over ¾ of an inch in thickness a deduction of 1 from the percentage of elongation specified in Sec. 5 shall be made for each increase of ⅛ in. in thickness above ¾ of an inch.
(b) For each decrease of $\frac{1}{16}$ in. in thickness below $\frac{5}{16}$ in., a deduction of 2½ per cent. shall be made from the specified elongation.	(b) For material under $\frac{5}{16}$ of an inch in thickness a deduction of 2½ from the percentage of elongation specified in Sec. 5 shall be made for each decrease of $\frac{1}{16}$ of an inch in thickness below $\frac{5}{16}$.

That Par. 16 of Sec. 1 of Part III be changed as follows:

PRESENT READING	PROPOSED READING
16. The variation in cross-section of weight of more than 2½ per cent. from that specified will be sufficient cause for rejection, except in the case of sheared plates, which will be covered by the following permissible variations: (e) Plates 12½ lb. per sq. ft. or heavier, up to 100 in. wide, when ordered to weight, shall not average more than 2½ per cent. variation above, or 2½ per cent. below the theoretical weight; when 100 in. wide and over, 5 per cent. above or 5 per cent. below the theoretical weight. (f) Plates under 12½ lb. per sq. ft., when ordered to weight, shall not average a greater variation than the following: Up to 75 in. wide, 2½ per cent. below the theoretical weight; 75 in. wide up to 100 in. wide, 5 per cent. below the theoretical weight; when 100 in. wide and over, 10 per cent. above or 3 per cent. below the theoretical weight. (g) For all plates ordered to gage there will be permitted an average excess of weight over that corresponding to the dimensions of the order equal in amount to that specified in the following table:	(a) When ordered to weight per sq. ft. the weight of each lot in each shipment shall not vary from the weight ordered more than the amount given in Table 1. (b) When ordered to thickness, the thickness of each plate shall not vary more than 0.01 in. under that order. The overweight of each lot in each shipment shall not exceed the amount given in Table 2.

While the present specifications provide for variations in weight for plates ordered to weight per square foot, it is customary to order boiler plates to gage only. If it is decided to change the rules in order to provide for gage only, only paragraph marked (*b*), as above, should be used, or the following from the A.S.M.E. Boiler Code could be used:

"The thickness of each plate shall not vary under the gage specified more than 0.01 in. (The overweight limits are considered a matter of contract between the steel manufacturer and the boiler builder.)"

Par. 18, 19 and 20 of Sec. I of Part III, dealing with the stamping of plates and heads, should be changed as follows:

PRESENT READING	PROPOSED READING
18. Each plate shall be distinctly stamped by the manufacturer with the heat number. 19. Each plate shall be distinctly stamped by the manufacturer in at least five places in the following manner: At the four corners, at a distance of about 12 in. from the edges, and at or near the center of the plate, with the name of the manufacturer, place where manufactured, brand and lowest tensile strength.	MARKING. (a) Each shell plate shall be legibly stamped by the manufacturer with the melt or slab number, name of manufacturer, grade, and the minimum tensile strength of the stipulated range, as specified in par. 9, in three places, two of which shall be located at diagonal corners, about 12 in. from the edge, and one about the center of the plate, or at a point selected and designated by the purchaser, so that the stamp shall be plainly visible when the boiler is completed.
20. Each head shall be distinctly stamped by the manufacturer on each side with the name of the manufacturer, place where manufactured, brand and lowest tensile strength, stamps to be so located as to be plainly visible when the head is finished.	(b) Each head shall be legibly stamped by the manufacturer in two places, about 12 in. from the edge with the melt or slab number, name of manufacturer, grade, and the minimum tensile strength of the stipulated range, as specified in par. 5, in such manner that the stamp is plainly visible when the boiler is completed.
	(c) Each butt strap shall be legibly stamped by the manufacturer in two places, on the center line about 12 in. from the end, with the melt or slab number, name of manufacturer, grade, and the minimum tensile strength at the stipulated range, as specified in par. 5.
	(d) The melt or slab number shall be legibly stamped on each test specimen.

It was claimed that the present Par. 20 had been interpreted by the Board as meaning that the head should be stamped not upon the two faces, but upon two sides, or edges, of the same face, so that the plate would not have to be turned over when the stamping was done. The tables referred to are those adopted by the American Society for Testing Materials. The heat number can always be identified by the slab number.

An informal discussion as to the legibility of stamping, and especially as to some means of locating the stamp marked upon the plate, ensued. Mr. Koopman, of the New England Boiler Works, said that on an average it cost a dollar a plate to find the stamp on a boiler. A legible stamp, easily found, was of great assistance to the boiler manufacturer, and five stamps on a plate made it easier to find one of them than as though there were but three.

Dr. Huston explained the impracticability of turning the plates over to stamp on both sides, and the difficulty of keeping the stamps sharp. The stamps became dull and legibility was reduced when they were obliged to stamp five times upon one sheet, instead of three. It was suggested that the name of the manufacturer might be etched in the rolls, and thus appear in raised letters upon the plate, as is done in the manufacture of pipe, the stamping being placed near one of these marks.

Dr. Huston stated that he had never been able to find any positive testimony that sulphur was detrimental. It is difficult to meet the requirements of the rule with regard to sulphur content when coal is used as a fuel, and the growing scarcity of natural gas makes steel manufacturers anxious about the reduction of the allowable amount of sulphur. Where a sufficient quantity of manganese is present the deleterious effects of sulphur are corrected. If you have 0.30 of manganese, which is the minimum specified, you can take care of 15 points of sulphur. The matter was being worked out by the Bureau of Standards coöperating with producing and consuming interests.

Mr. Scannall, of the Scannall Boiler Works, Lowell, Mass., argued that heads should be stamped upon both sides, that is, upon both faces, and Mr. Koopman, of the New England Boiler Works, explained the difficulties which the boiler manufacturers got into by using ready-flanged heads, some of which had to be stamped on the convex and some on the concave side to make the stamping come on the outside of the boiler as built.

C. M. Flagg & Co., Inc., of Meriden, Conn., petitioned that Par. 68 of Sec. 4 of Part III be amended as follows:

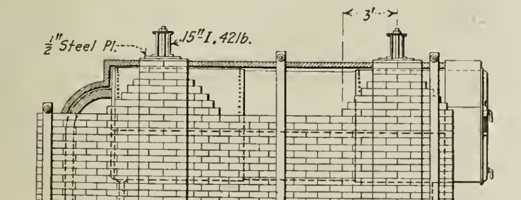
PRESENT READING	PROPOSED READING
68. A horizontal return-tubular boiler over fifty-four (54) inches in diameter, and up to and including seventy-eight (78) inches in diameter, shall be supported by the outside-suspended type of setting, or by not less than four (4) steel or cast iron brackets on each side set inside.	A horizontal return-tubular boiler over fifty-four (54) inches in diameter, and up to and including seventy-eight (78) inches in diameter, shall be supported by the outside-suspended type of setting, or by not less than four steel or cast-iron brackets on each side set in pairs, or suspended from beams supported on the brickwork of the boiler setting which has been carried up for this purpose, and provided that the outside wall of such a setting be not less than twenty-two (22) inches face to face of side wall, and the extension above the fire stop not less than twelve (12) inches face to face. The top of such extension or pier shall be not less than twelve by twelve (12x12) inches, covered with a suitable iron plate, and shall be carried down front and rear at an angle of not less than forty-five (45) degrees to the top of the wall.

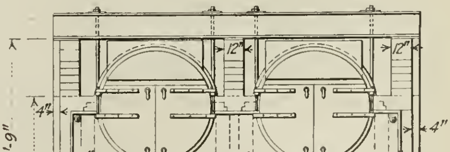
C. N. Flagg & Co. are setting boilers as shown in the engraving at the bottom of this page, and consider this method of suspension safer than lugs bearing upon only the softer portion of the wall. The petition does not contemplate the use of this form of setting where columns are required, but only as a substitute where lug support is permitted. Lugs are supported on the portion of the setting least adapted to carry a load. The load with this form of setting is more widely distributed, and it provides for movement in all directions. Rollers under lugs cannot move endwise. Mr. Flagg explains that the top of the boilers were paved with brick or silocel and that a small opening was left around the hanger to be filled with asbestos.

Mr. Jeter said that they had many explosions in which the boiler did not show any reason why it should have failed. Most of these explosions they attributed to settling of the setting. He did not believe that an accident of that character could happen to a boiler that was suspended in this way.

Mr. Luck, chairman of the Board, inquired whether this method of suspension would have any particular effect upon lug cracks, and was answered that it would have no other effect than any other method of suspending the boiler would have.

Mr. Heinrich, of the Travelers company, spoke of the accessibility of boilers suspended in this way for inspection. Mr. Flagg explained, in reply to questions by the Board, that the plate covered the top of the column or pilaster and the beams went to the outside of the wall.





Elevator Laws of the State of Pennsylvania and the City of Philadelphia

By EDWARD A. SMITH

Mechanical Engineer, Otis Elevator Co., New York, N. Y.

EXCERPTS from elevator laws of the Department of Labor and Industry, as revised to Dec. 13, 1917, for the State of Pennsylvania, except Philadelphia, Pittsburgh and Scranton, for power-driven passenger, freight and sidewalk elevators.

Load: Passenger—80 lb. per sq.ft. inside area car. Hospital Passenger—60 lb. per sq.ft. inside area car. Metal capacity plate with suitable letters, giving load, speed, size, number and material of cables. Freight—No regulation, except for automobile lifts which require platform of strength to sustain a load equal to 70 per cent. of live load concentrated at any two points 4 ft. 8½ in. apart on a line parallel to car sill.

Speed: Passenger—Shall not exceed 600 ft. per min.; over 600 ft., special permission required. Freight—125 ft. per min.; over 125 ft. special permission required; 75 ft. per min., belt and chain power-driven machines; 50 ft. per min. with horizontal self-closing hatch doors.

Current: Passenger and Freight—Not more than 250 volts permitted in any car switch or button control without special permission.

Runby at Top: Passenger — Minimum between highest point of carframe and any overhead construction: Speed feet per minute, 100, 200, 300, 400, 500 and 600; runby in feet, 5, 5, 6, 7, 7 and 8 respectively. Minimum for plunger passenger elevators 5 ft. for all speeds. Freight—Minimum between highest point of car-frame and any overhead construction shall be 4 ft.

Pit: Passenger—Minimum between bottom of car and pit when car is at lowest land: Speed feet per minute, 100, 200, 300, 400, 500 and 600; pit depth in feet, 4, 4, 4, 5, 6 and 7 respectively. Minimum for plunger passenger elevators, 4 ft. for all speeds. Freight—Minimum between underside of car and pit with car at lowest landing shall be 3 feet.

Safeties and Governor: Passenger — Safety under car, speed over 100 ft. per min. Friction clamp operated by centrifugal governor. Rise 20 ft. and speed not more than 100 ft. per min., broken rope spring grip safeties may be used. Roll safeties may be used up to and including 100 ft. per min. with governor. All safety slings to be of steel. Safe-lifting elevators to have locking device. No safeties required on plunger elevators. Freight—Over 20-ft. rise, must have safeties under car operated by centrifugal governor. Speed over 100 f.p.m., must be wedge clamp. Speed 100 ft. per min. or under, roll safety with governor may be used. Under 20-ft. rise, spring-grip safeties accepted. Sidewalk—25-ft. rise, no safety required. If located inside of building, same requirements as freight elevator.

Car Enclosure and Platform: Passenger—Enclosed on all sides and top. If grille, sides to be covered with ⅜-in. screen 6 ft. high. Entrances at not more than two sides. With gates at openings (if electric elevator), gates to have contacts. Emergency exits in top of car or, if two cars in same shaft, side exits. Nonslip floor 2 ft. from edge. Rubber tile floor is considered as nonslip. Landings and floors of cars to be lighted during operation. No horizontal or vertical compartments permitted. Freight—Enclosed solid 6 ft. high (or to car beam if lower). Top solid or No. 10 wire 1½-in mesh. Car tops not to be cut back more than 6 in. from sill, hinged section 18 in. back. More than one opening requires folding or vertical semiautomatic gate, standard height, body to conform to clear height desired, no contact. (Department of Labor, 3-17-19.) Top not required with trapdoors or with enclosed hatchways having upper floor gates extending to floor. Sidewalk—No regulation. Bow iron to be provided unless doors are opened by hand and controlling device arranged to hold car immovable until doors are opened. Not permitted inside of building.

Control: Passenger—Switch, hand-wheel or lever. Push-button for private houses only. Special permission for other push-button installations.

Gates: Passenger—Not permitted. Freight—Enclosed hatchways with fire-doors on outside of shaft require semiautomatic gates. Gates not required with fire-doors on inside of shaft. Open hatchways to have semi-automatic gates of metal or hardwood, gates to have joints reinforced with metal. Wood slats 2 in. between or 2-in. wire mesh. All gates 5 ft. 6 in. high with locks, 6 in. underclearance, 2 ft. 6 in. underclearance with trapdoors. Double blade gates to be covered with ⅜-in. mesh. At street openings or outside of building, a gate must be furnished 6 ft. high, 2-in. underclearance and covered with 1½-in. wire mesh. Exceptions when local conditions will not permit. Flexible type gates permitted. Sidewalk—Semiautomatic gates to be provided at bottom and intermediate floors. Removable railing required to prevent operation of car until rail is in place. Bow irons on car required.

Ropes: Passenger and Freight—Not less than two ropes to car and counterweight. Must be iron or steel. Governor ropes iron for all passenger. Manila for freight 100 ft. per min. or under. Swedish iron over 100 ft. per min., freight. Drum machines to have two full turns on drum when car is at lowest stop. Ends of cables clamped on inside of drum. All cables to have fastening approved by board. Cables outside of hatch to be enclosed all sides 6-ft. high. Sidewalk—Chains or cables permitted. Sheaves for cables 12 in. diameter minimum.

Equalizers: Passenger and Freight—All cables except for traction elevators.

Bumpers: Passenger and Freight—Spring, oil, air cushion or other device strong enough to absorb momentum of car loaded. No requirement for bumpers under counterweight.

Grating: Passenger and Freight—Iron, 1-in. space between bars, 2-in. wood platform or reinforced concrete under all machinery, sustaining 50 lb. per sq.ft. To cover entire hatchway, except where hatchway exceeds 100 sq.ft. must have approved railings and toe guards. If door is placed in grating it must hinge up and be self-closing and accessible from top of car. Existing gratings may remain if sufficiently strong.

SCREENS NOT REQUIRED WITH CHAINS

Counterweight Screens: Passenger — Bottom 8-ft. high (Not required with counterbalance chains), top 10-ft. long. Where counterweights are outside of shaft must be entirely enclosed all sides. Freight—No regulation except if counterweight runs outside of shaft, must be entirely enclosed on all sides.

Stop Motion and Shaft Limits: Passenger—Drum-type machines to have machine limits. Electric machines, drum or traction, to be provided with upper and lower limits on car or shaft. Stop balls on hand rope accepted for shaft limits on existing elevators. Hydraulic plunger elevator, speed 100 ft. or less, must have independent rope with stop balls actuated by car. Rope to be attached to lever or operating sheave. On horizontal or vertical hydraulic machines, 100 ft. speed or less, use independent rope connected to operating valve and operated by traveling crosshead. If speed exceeds 100 ft., independent automatic cutoff valves to be provided. Above apply to hydro-steam and hydro-pneumatic where applicable. Freight—Limit switches for all traction machines in shaft or on car; also for drum machines above a speed of 75 ft. per minute. All drum machines to have machine limits. For hydraulic machines, same as passenger. Sidewalk—Machine limits required on electric machines. Hatchway limits not required.

Interlocks: Passenger—Approved electric or mechanical or electro-mechanical to be provided on all elevators, with approved emergency release under glass cover outside of shaft at main landing. Release to be connected with bell which will ring continuously during release period. Release sign to be provided giving directions for use. Wires to run in conduits where possible, as per National Electrical Code. Sidewalk—Removable railing required to prevent operation of car until rail is in place at sidewalk or a device to hold car immovable until sidewalk doors are opened by hand.

Emergency Switches: Passenger—Magnet switch on controller to automatically stop machine when current is interrupted. Electric car switch to be self-centering and self-locking. Emergency switch in car in series with main line, independent of car switch, wheel or lever. Proper fuses or circuit-breakers to be furnished. Slack-cable device required on all drum machines. Freight—Signal bell in car to be operated from each floor and to be heard at any floor. Slack-cable device for drum machines. Proper fuses or circuit-breakers to be furnished. Sidewalk—Slack-cable device and hatchway limits not required.

Rope Locks: Passenger—Not permitted. Freight—Required to prevent operation of car except from landing where car stands.

Hatchway Enclosures: Passenger—Existing shafts where grills are used, to be extended full height at entrance and on sides where there are stairways and further protected by ⅜-in. mesh wire screen 6 ft. high over all moving parts within 4 in. of enclosure. Freight and Dumbwaiter—Existing shafts, solid wood ⅞ in. thick or 2-in. mesh No. 10 gage 6-ft. high allowed. Sidewalk—Lower and any intermediate landings to have substantial enclosure 6 ft. high all sides except loading.

Hatchway Doors: Passenger—Fireproof horizontal sliding doors only, as near flush with inside of shaft as possible. To be unlocked from inside only except at main landing, where key may be used to unlock from outside. Doors may have ¼-in. thick wire glass in metal frames, no one pane to exceed 250 sq.in. between mountings. Swinging doors may be used with push-button elevators. Freight—Enclosed hatchways require fire-doors inside hatch, but may be put on outside if semiautomatic gates are used. Doors may be operated by hand or by mechanical device. If manually operated, to be equipped with interlocking device. Doors not to be unlocked from outside except with removable key and except where doors have interlocks. Door sills must be beveled with metal or metal-faced wood at an angle not less than 60 deg. with horizontal. Open hatchways require automatic self-closing fire-doors except for two-story buildings or less (see paragraph on gates). Sills to be beveled as above. Sidewalk—Horizontal hatch doors at sidewalk level. No other doors required. (See paragraph on gates).

Not Permitted on Passenger Lifts

Trapdoors: Passenger—Not permitted. Freight—To be used only with shafts that are not required to be enclosed; not required for buildings two stories or less. Sidewalk—Permitted at sidewalk level.

Motor-Room Enclosure: Passenger and Freight—If over hatch to be fireproof and have fireproof door to roof and locked. No other regulation.

Automobile Lifts: Four-corner automobile freight elevators allowed for rise one story, 15 ft. rise, with maximum capacity of 5000 lb. For regular construction, same as freight elevators.

Belt Machine: Single or double-belt machines or chain permitted for freight service only. If counterweighted; up to 5000-lb. capacity, for four-story rise, centering rope required.

Operator: Competent operator over 18 years old with license where there are local laws to that effect.

Hydraulic Tanks, Valves and Cylinders: Valve chambers and cylinders designed to remove accumulation of air. Crossheads of vertical hydraulic cylinder to travel in guides of structural shapes. No continuous forged straps permitted for traveling sheaves. Use two part structural shapes. Where power pumps are used, a bypass or safety valve to be furnished to avoid increase of 15 lb. above working pressure in tank, in addition to main safety valve. Plunger heads rigidly secured to platforms. Plunger more than three sections and counterweighted to have noncorrosive cable between bottom of plunger and platform.

Plunger safe-lift elevators or emergency loads, rise more than 75 ft., to have traveling follower always midway between stuffing-box and car. Pressure tanks to have factor of safety of 5; must have water glasses. Overhead tanks to have air checks. Hydro-steam and hydro-pneumatic to comply with above as far as applicable.

Installation Prohibited: Handpower with rope grip. No elevator over passageway. No back-guide elevators permitted. No elevators operated by friction gearing or clutch. No machinery (except plunger) to be located under elevator shaft. No setscrews fastenings in lieu of keyway. Pawl-and-ratchet safety not permitted.

Philadelphia Elevator Laws

In most cases the elevator code of the City of Philadelphia, approved Apr. 15, 1908, and rules issued Aug. 28, 1919, conform with the Pennsylvania State Labor Laws, the chief exceptions being given in the following:

Safeties and Governor: Passenger—Gradual applied safety under car operated by centrifugal governor over 125 ft. per min. Instantaneous safeties may be used up to and and including 125 ft. per min., rise two stories or 30 ft. All safety slings to be of steel. Safe-lifting elevators to have locking device. No safeties required on plunger elevators. Design of safety to be approved by Department of Public Safety. Freight—Must have safeties under car operated by centrifugal governor. Speed over 125 ft. per min. must be gradual safety. Speed 125 ft. per min. or under, instantaneous safety with governor may be used. Sidewalk—25-ft. rise, no safety required. If located inside of building, same requirements as freight elevator.

Ropes: Same as state code except all cables fastened by shackles—no leaded sockets allowed except under special conditions where used in connection with traction machines, and these must have means of adjustment.

Equalizers: Passenger and Freight—All cables must be equalized or have means of equalizing same.

Bumpers: Passenger and Freight—Spring, up to and including 250 ft. per min. 10-story rise, or other approved device constructed to arrest a runaway car. Over 250 ft. per min. or 10-story rise, buffers of approved type or other approved device for arresting runaway car. No requirements for bumpers under counterweight.

Hatchway Enclosures: Passenger, freight and sidewalk—All shaftways must be fireproof excepting existing hatchways, and these can be protected by fuse link or full-automatic hatch doors. In this case the weight box has to be covered with tin and asbestos and the underside of the doors has to be covered with tin and asbestos. Existing shafts may be enlarged 33⅓ per cent. without being required to make same fireproof. Shafts to be flush with hatchway. Windows in hatchway to be covered by a substantial grille or screen.

Hatchway Doors: Passenger and Freight—Fireproof horizontal sliding or swinging doors as near flush with inside of shaft as possible. To be unlocked from inside only except at main landing, where key may be used to unlock from outside. Doors may have ¼-in. thick wire glass in metal frames, no one pane to exceed 250 sq.in. between mountings. Swinging doors may be used with push-button elevators. Existing hatchways to have doors with fuse links.

Trapdoors: Passenger and Freight—Full automatic permitted on existing hatchways. Sidewalk—Permitted at sidewalk level.

Motor-Room Enclosure: Passenger and Freight—If over hatch to be fireproof and have fireproof door to roof and locked. Free and safe access to all elevator machinery. No other regulation.

Operator: Competent operator over 18 years old with license—fee $1.00, renewal $0.25 annually. No elevator operated without certificate of inspection in car. Fine $50 for operating without certificate.

Information comes from the American Association of Engineers, which was founded in 1915, that its membership now exceeds 8800. On the first of January, 1919, the association had less than 2500 members. Within the last 11 months it has grown at a remarkable rate. On Nov. 20 the membership reached 8866. The first two weeks in December had been set aside for a country-wide drive to increase the membership by 10,000 in 13 days. The successful termination of the drive will make the association one of the largest engineering organizations in the country.

Power Supply And Generation Of The Future

It has been many a day since Chicago engineers listened to a more interesting lecture than that delivered by Dr. Charles P. Steinmetz on the evening of Oct. 29. The occasion was a joint meeting of the Chicago Section of the American Institute of Electrical Engineers and the Electrical Engineering Section of the Western Society of Engineers. Fullerton Hall, at the Art Institute, where the meeting was held, was packed to overflowing. Upon his appearance the doctor was given a rousing welcome, and the great interest that his address imparted was made evident by the innumerable questions on every conceivable source of power hurled at the speaker long after his formal talk had ended.

Introducing the subject, Dr. Steinmetz pointed out that the two essential things on which the very existence of mankind depend, are materials and energy. Both are indestructible. While they may be changed in form, neither can be created or destroyed and it is necessary to call on nature's storehouse. Materials of all kinds can be transported all over the world from their origin to the point of use. Energy, on the other hand, must first be conveyed from the place in which it is found to where it is needed and then be converted into another form of energy. There are only two forms of energy transportable—chemical energy in coal or other fuel and electrical energy. In the present day the two main sources of energy are coal and the waterfall, oil and gas playing a small part compared to coal. Power from the waterfall cannot be transported in the form of chemical energy, as in the case of coal. Unless used at the source, it must be transferred into electrical energy and distributed in this form. In fact, the development of electrical energy made possible the distant use of water power.

Briefly, the speaker referred to the present great expansion of the new industry of power generation and distribution. A great network of distributing lines cover the country. Generating stations, hydraulic and steam, are tied together and entire systems linked one to the other. To eliminate transportation of chemical energy, current is being generated at the mines and in common with other large stations, is being distributed in bulk at high voltage and then in smaller quantities at lower voltage to the points of use.

As to the amount of energy available in coal and water, the speaker gave the annual consumption of coal, including the coal equivalents of oil and gas, as 800 million tons. Piled as high and wide as the Chinese wall, this immense quantity of coal would extend entirely around the border and coast lines of the United States. The energy represented in this coal would blow this great wall 200 miles into the air.

In a crude way the total energy from water power can be estimated from the rainfall and the elevations of the various parts of the country. Figuring the energy from every drop of water in passing from its particular elevation to sea level, however, would give a potential water power of 1000 million kilowatts. Some of this water, however, would be needed for agriculture and there would be loss from seepage into the ground, evaporation, etc., so that from the water that was left, the extreme maximum that ever could be developed would be 200 million kilowatts, and not over one-half of this would be economically feasible.

In the 800 million tons of coal the chemical energy would be equivalent to about 800 million kilowatts per year, or four times the total power available from water. However, in converting the chemical energy in the coal the efficiency ranges from 10 to 40 per cent. When converted into heat the efficiency averages from 30 to 40 per cent., and only 10 to 12 per cent. for conversion into mechanical energy. The probable average is 25 per cent., so that one-quarter of 800 million, or 200 million kilowatts, would be available from coal, a figure equivalent to the maximum available water power. With the coal consumption increasing at the rate it has in recent years, the supply will soon be exhausted. To replace it entirely by water power must be a dream, although hydro-electric development will help to conserve it.

Already the country is approaching the limit of water-power development by present methods of concentrating in large stations. Much more power could be obtained by a very large number of small units scattered along every possible stream where the gradient and economic conditions warranted. These units might preferably consist of cheap hydraulic turbines coupled to induction generators which will develop electrical energy at any speed, and in attendance would require only occasional visits for general supervision. Through step-up transformers these various units could feed into the main system of the region.

One of the great problems of the future is to utilize more fully the energy in coal. The efficiency of converting chemical energy into electrical energy averages only 10 per cent., and there is a great waste of heat energy wherever coal is burned for this purpose. Heat can be transmitted only over comparatively short distances, so that the problem evolves into first getting all the electrical energy possible wherever coal is burned for heat, such as is now being done in private plants, and eventually the same method might be extended to the homes. Steam turbines coupled to induction generators would collect the electrical energy and feed it into central station mains. Credit would be allowed for the current furnished, but must be purchased at a much lower rate than that supplied by the central station, as in the latter case electrical energy is furnished when and where desired and at the proper voltage. From the private plant the current would be supplied irregularly over a separate transmission line and must be transformed to meet the requirements of the service with the possibility that there might not be a market for it when delivered.

As to other sources of energy, relatively small quantities furnished irregularly is to be expected of the wind. It is true, tower lines might be erected with an induction generator driven by an air motor on each tower, the current passing through a transformer into a general transmission system. The whole country could be covered with these lines, which could criss-cross in all directions, but there would be few places where such an arrangement would be economically feasible.

Tide mills with the accompanying reservoirs are practically hopeless as economical power producers, and wave power must be considered as irregular and impractical. Utilizing the solar energy to develop power by trapping the sun's rays under glass is hopelessly complex and inefficient, although great quantities of solar energy are available. Assuming that the sun shines one-half the time and taking into account that it is not always high up in the heavens, the total energy available from light rays from the sun has been estimated at 800,000 million kilowatts. If it were possible to collect all the solar energy not required by agriculture, say on arid territory, there would still be available 100,000 million kilowatts, more than one hundred times as much as is available in the yearly coal consumption and far more than is available from both coal and water. Development of this great resource will be left to engineers far in the future when other sources fail.

The speaker predicted that in a comparatively short time electricity will supply the world with power just like the railways now supply transportation. The country will be covered with a network of distribution lines fed from the various sources mentioned, and the cost of power will be relatively lower as the systems expand and use for all purposes becomes more general.

Professional Engineers In Iowa Must Register

Unless engineers desiring to practice in Iowa register before July 4, 1920, they will be guilty of a punishable offense should they continue to practice. All professional engineers and land surveyors are included in the law which requires registration upon their professional requirements without examination up to Jan. 4, 1920. Thereafter until July 4, 1920, technical examination before the Board of Examiners is required. After the latter date the law is in full force. The penalty is a fine of not less than $100 nor more than $500. K. C. Kastberg, Des Moines, is secretary of the Board of Examining Engineers. Other members are Seth Dean, L. M. Martin, F. W. Stubbs and Alvin Le Van.

"WONDER WHO WOULD HAVE WON THE BATTLE OF BUNKER HILL WITH THIS KIND OF PUBLIC SPIRIT?

The Tiny Tribune.
VOL III. DEC. 2, 1919. NO. 221
STRIKES
STRIKES!!
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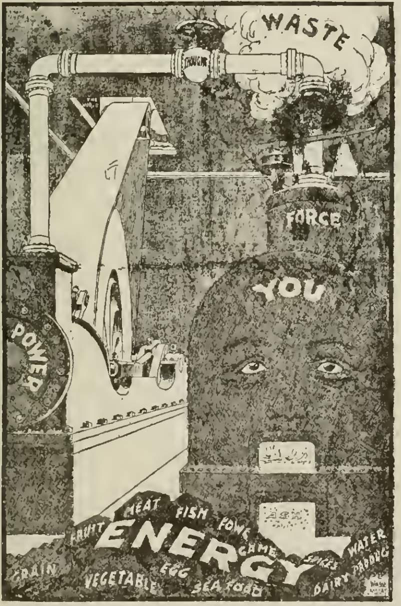
STRIKES!!!
The Tiny Tribune
"HOW'D YOU STOP IT?"

Get Out of the Way!

—From *The Providence Daily Journal*

MAN, ENGINE AND THINKER

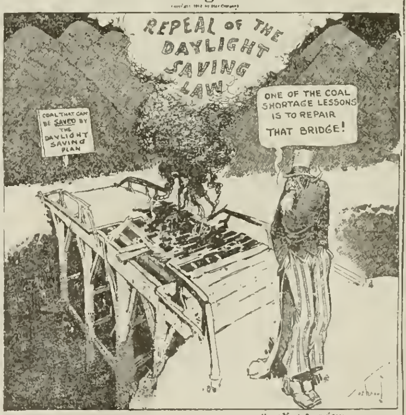


From the Scientific Point of View This Picture Is YOU, AN ENGINE, Consuming a Certain Amount of Fuel in the Form of Meat, Bread, Etc., and Producing a Certain Amount of Energy. Mr McCay, the Artist, Shows YOU as the Furnace Creating a Force That Goes Over to the Engine Which May Be Called Your Brain. That Brain, if Hooked to Some Useful Task by the Driving Belt of Real WORK, Does Its Share in the Big Cotinde Factory Called the World.

YOU Are All That Is Shown in This Picture AND YOU ARE MORE THAN THIS PICTURE SHOWS, THE CUSTODIAN, GARDENER AND DEVELOPER OF THIS EARTH

New York American

The Burnt Bridge Behind Him


REPEAL OF THE DAYLIGHT SAVING LAW
COAL THAT CAN BE SAVED BY THE DAYLIGHT SAVING PLAN
ONE OF THE COAL SHORTAGE LESSONS IS TO REPAIR THAT BRIDGE!

New York American

TIMELY NEWSPAPER CARTOONS REGARDING THE COAL SITUATION

Water Power in France

The great national scheme for the development of the hydraulic resources of France which is now before the French Chamber has immense potentialities for the future of the electrical industry in that country.

Reviewing the hydraulic resources of other countries, M. Rerrier, deputy for the Isere, says that although these estimations can only be approximate, they nevertheless yield certain relative indications. Thus the average flow water power of Norway is estimated at 7,500,000 hp.; Sweden, 6,750,000 hp.; Austria-Hungary, 6,750,000 hp.; Italy, 5,500,000 hp.; Spain, 5,000,000 hp.; Switzerland, 1,500,000 hp.; Germany, 1,450,000 hp., and Great Britain, 963,000 hp. France, with 9,000,000 hp., is therefore the richest European country in waterfalls. Its resources are approximately divided as follows: Alps, 4,500,000 hp.; Central Massif Vosges and Jura, 1,700,000 hp; Pyrenees, 2,000,000 hp., and other districts 800,000 hp. Of this total of 9,000,000 hp. only 750,000 hp. was developed in 1913—350,000 hp. for transmission of power and 400,000 hp. for electrochemistry and electrometallurgy. France thus utilizes only one-tenth of her available power. In 1913 the capital employed in the hydro-electric industry totaled 800,000,000 fr. ($160,000,000), or 500,000,000 fr. ($100,000,000) in the distribution of energy and 300,000,000 fr. ($60,000,000) in electrochemical and electrometallurgical undertakings.

Since the outbreak of the war remarkable progress has been made in the utilization of French water-power resources. According to M. Cohen, between 1916 and 1918 the water power developed amounted to 450,000 hp., in 1919, 125,000 hp. is to be complete, and in 1920-21, 275,000 hp., or a total of 850,000 hp. The hydraulic power in 1921 would therefore be 1,600,000 hp., or 16 to 20 per cent. of the available power, such as it has been estimated to be. The new capital invested in the hydro-electric industry amounts to 660,000,000 fr. ($132,000,000). In 1921 there will therefore be 1,460,000,000 fr. ($292,000,000) employed in hydro-electric undertakings—865,000,000 in transmission, 500,000,000 in electrochemistry and electrometallurgy, and 95,000,000 in electric traction. These extremely remarkable results have been secured by the joint labors of private initiative and government action. The State owns and works three hydro-electric undertakings, one driving a munitions factory, another supplying a cyanide works with power, and a third for the service of the city of Toulouse.—*L'Electricien.*

New Publications

A STUDY OF THE FORMS IN WHICH SULPHUR OCCURS IN COAL

In the Chemistry Department of the Engineering Experiment Station of the University of Illinois, a thorough investigation has been made of the nature of the four sulphur compounds in coal, the quantity of each form present, and the change which characteristic forms undergo when the coal is allowed to stand or is subjected to coking. The following methods were developed for the quantitative analysis of each form of sulphur: (1) The sulphate sulphur was determined by extraction of the coal with dilute hydrochloric acid. (2) The pyritic sulphur was determined by extraction of the coal with dilute nitric acid; it having been found that nitric acid of a certain dilution has a selective action on sulphur combined as iron pyrites. (3) The resinic sulphur was determined by extraction of the coal with phenol. (4) The humus sulphur was determined either by a direct method or by the difference between the sum of the other three forms and the total sulphur in the coal.

The devising of such methods of analysis has been much sought after in recent years by coal and coke investigators, but without satisfactory results up to the present time. The methods here proposed have been put to extended tests with exceedingly satisfactory results. These investigations, which were made by A. R. Powell with Prof. S. W. Parr, are published in Bulletin 111 of the Engineering Experiment Station. Copies of this bulletin may be had without charge by addressing the Engineering Experiment Station, Urbana, Ill.

Miscellaneous News

Paducah City, Ky., voted $260,000 for improvement to its electric light and power plant. The improvements are to be started at once.

Kentucky and West Virginia Power Co., Lothair, Ky., recently increased to $6,000,000 capital, will erect a large power-plant addition, beginning at once. R. E. Breech, president, is located at 30 Church St., New York, and F. R. Weller, consulting engineer, Hibbs Building, Washington, D. C. The company will extend high-powered transmission lines into Elkhorn and Hazard coal fields, supplying 90 per cent of the operating coal companies. It is also planned to extend lines into the Elkhorn field of West Virginia. The company recently took over two good-sized power companies in the latter state.

The Monongahela Valley Traction Co.'s plant at Parkersburg at the present time has equipment installed to develop a load of 5000 kw. or about 6700 hp. This is considerably in excess of the present demand, as the load averages about 8600 kw. during the day and only about 2000 during the night. However, in anticipation of an increased power demand in the future, the company is at present getting ready to double their present capacity by installing equipment necessary to bring the capacity up to 10,000 kw. This will mean that the company will be able to offer attractive power rates to incoming industries, and also that they will be able to supply the demand when the industries arrive.

The National Association of Stationary Engineers' Educational Committee has issued a 46-page booklet of its lantern slide lecture on "The Diesel Engine." This contains about fifty slides showing the Diesel engine in its various stages, makes and sizes from the first American-built Diesel of 60 hp. to the higher horsepowers of the present day. Copies of this lecture are for sale by the N. A. S. E. Educational Committee, 811 W. Dayton St., Madison, Wis., at 25 cents to members and 50 cents to nonmembers.

Business Items

J. G. White & Co., Inc., announces the removal of its offices to 37 Wall St., New York City.

The Ingersoll-Rand Co., New York City, has opened a branch office in the Sam Houston Life Building, Dallas, Texas, with R. H. Brown, Jr., as manager. Previous to this Mr. Brown was connected with the company's St. Louis office.

No O-40 Ed M Dept Bus Notes

The M. H. Detrick Co., Chicago, Ill., have completed arrangements for representation on the Pacific Coast with S. Herbert Lanyon, sales engineer, 507 New Call Building, San Francisco, Cal. They have also just recently arranged with H. A. Paine, 1302 Nance St., Houston, Texas, for representation in Texas.

T. H. Burton, formerly connected with the Page Boiler Co., of Chicago, announces the organization of the De Pere-Burton Co., of Milwaukee, for the purpose of manufacturing the Burton type of boiler, with improvements over his former designs. The new firm has large manufacturing capacity and a shop with a record for successful bailer manufacturing for a number of years.

Trade Cataolgs

The Kerr Turbine Co., Wellsville, N. Y., has issued a 27-page catalog, entitled "Kerr Economy Marine Equipment," which fully illustrates and describes in detail all about Kerr marine turbines.

The Nashua Machine Co., Nashua, N. H., has issued a 15-page booklet on "The New Bundy Steam Traps," which fully describes this particular type of trap and gives ratings with actual tests with traps ranging in size from 5 to 250 lb.

The Richardson-Phenix Co., Milwaukee, Wis., has issued an interesting 16-page catalog describing the "Nokut Pump Valve." It gives list prices, sizes and dimensions of various types and sizes of pump valves. A copy may be had free upon request.

The Black & Decker Manufacturing Co., Baltimore, Md., has issued its full catalog, giving a complete description, with illustrations, of its electric air compressors, portable electric drills, and electric valve grinders. Copy may be had free upon application.

The Allis-Chalmers Co., Milwaukee, Wis., has issued bulletin No. 1632-C on "Centrifugal Pumps" and bulletin No. 1537 on "Details of Allis-Chalmers Oil Engines—Diesel Type." Both bulletins are well illustrated and treat their respective subjects well. Copies may be had free upon application.

Walter A. Zelnicker Supply Co., St. Louis, Mo., has issued a 56-page bulletin, No. 270, entitled "The Nation's Market Place," which lists rails, locomotives and their accessories, machinery for power and industrial plants, contractors equipment, pipe of all kinds, steel piling, tanks, etc. Copy free upon request.

The Clarage Fan Co., Kalamazoo, Mich., is sending out upon request a little booklet entitled "A Dance, A Fan and the Girl." A bit of romance makes the story worth reading. Features of the fan are brought into the story in an interesting fashion. Emphasis is placed on the good points of the bearings and the fact that the fans are adjustable and reversible.

The Standard Oil Co. has issued a very interesting 112-page illustrated booklet entitled "Fuel Oil Installations." The object of the work is to give prospective users of fuel oil a practical knowledge of the factors governing both the installation and operation of fuel-oil burning plants. Under each type of plant are mentioned the various advantages in the use of fuel oil. The main considerations entering into the question of fuel-oil burning are treated in a general and practical manner. Sufficient details are given of typical plants so that prospective users can form an accurate estimate, governed by local conditions, of the cost involved in making the installation, as compared to savings effected in operation by using oil fuel. Chapters on "Fuel Oil and Its Properties," "Advantages in the Use of Fuel Oil," "Fuel Oil Burners and Methods of Atomization," "Equipment Required in Oil Burning Systems," "Oil Burning Boiler Plants," "Special Applications of Oil Burning Installations," and Results of Boiler Tests Burning Oil Fuel" are well covered. A comparison between the equivalent cost values of coal and oil is made in Chapter II, which should be of value in making a decision as to the proposed use of fuel oil in a plant. Seven useful tables on the following subjects are given: "Relative Value of Coal and Oil," "Amount of Air Required Per Pound of Various Fuels," "Calorific Values and Specific Gravity of Various Fuels," "Properties of Saturated Steam," "Sizes of Oil Fuel Stacks," "Tank Capacities," "Conversion Tables of English to Metric Units."

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$8.20@$8.65
Stove	8.45@ 9.05
Chestnut	8.55@ 0.05
Pea	7.05@ 7.40
Buckwheat	3.60@ 3.80
Rice	2.30@ 2.50
Barley	1.25

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2.85@$3.35	$3.15@$3.60
F.o.b. Philadelphia, gross tons	5.05@ 5.60	5.35@ 5.90
F.o.b. New York, gross tons	5.40@ 5.95	5.75@ 6.25
Alongside Boston (water coal), gross tons	7.00@ 7.75	7.60@ 8.00

Pocahontas and New River are practically off the market for coastwise shipment, but are quoted at $6.25@$7.00.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports are as follows:

Anthracite

	Company Coal
Broken	$7.80@$8.25
Egg	8.20@ 8.65
Stove	8.45@ 9.05
Chestnut	8.55@ 9.05
Pea	7.05@ 7.40
Buckwheat	5.15
Rice	4.50
Barley	4.85
Boiler	4.85

Bituminous

	Spot
South Fork (best)	$3.25@$3.50
Cambria (best)	3.00@ 3.25
Cambria (ordinary)	2.60@ 2.80
Clearfield (best)	3.00@ 3.25
Clearfield (ordinary)	2.60@ 2.90
Reynoldsville	2.85@ 2.90
Quemahoning	3.25@ 3.50
Somerset (medium)	3.00@ 3.25
Somerset (poor)	2.60@ 2.75
Western Maryland	2.50@ 2.75
Fairmont	2.25@ 2.50
Latrobe	2.60@ 2.80
Greensburg	2.75@ 3.00
Westmoreland ¾ in.	3.40@ 3.50
Westmoreland run-of-mine	2.75@ 3.00

PHILADELPHIA—Anthracite prices are practically the same as those listed above for New York. Bituminous coal prices vary according to district from which they are mined. For ordinary slack the price is $2.45@$2.65; lump, $3.00@$3.35.

BUFFALO—

Anthracite

	On Cars, Gross Ton	At Curb, Net Ton
Grate	$8.65	$10.80
Egg	8.80	10.65
Stove	9.00	10.85
Chestnut	9.10	10.85
Pea	7.75	9.30
Buckwheat	5.70	7.75

Bituminous

Allegheny Valley	$4 80
Pittsburgh	4.65
No. 8 Lump	4.65
Mine Run	4.80
Slack	4.10
Smokeless	4.60
Pennsylvania Smithing	5.70

CLEVELAND—Prices of coal per net ton delivered in Cleveland are:

Anthracite

Egg	$11.75@$11.90
Chestnut	12.00@ 12.00
Grate	11.75@ 11.90
Stove	11.80@ 12.10

Pocahontas

Mine-run	$7.60

Domestic Bituminous

West Virginia splint	$8.50
No. 8 Pittsburgh	$6.60@ 6.90
Massillon lump	8.25@ 8.50
Coshocton lump	7.15

Steam Coal

No. 6 slack	$5.25@$5.50
No. 8 slack	5.10@ 5.50
Youghiogheny slack	5.25@ 5.50
No. 8 ¾ in.	5.70@ 6.00
No. 6 mine-run	6.25@ 5.50
No. 8 mine-run	5.75

Only coal available is mine-run Pocahontas.

MIDDLE WEST—Chicago quotations, F.o.b. cars at mine:

	Springfield Carterville Williamson Franklin Saline Harrisburg	Fulton Peoria	Grundy La Salle Bureau Will
Lump	$2.55@$2.70	$2.95@$3.10	$3.25@$3.40
Washed	2.75@ 2.90	....	3.45@ 3.60
Mine Run	2.35@ 2.50	2.75@ 2.90	3.00@ 3 15
Screenings	2.05@ 2.20	2.35@ 2.50	2.75@ 2.80

New Construction

PROPOSED WORK

Me., Biddeford—The Saco-Lowell Co., 77 Franklin St., Boston, is having plans prepared for the construction of a 2 story machine shop and foundry. A steam heating system will be installed in same. Total estimated cost, $200,000. Lockwood, Greene & Co., 60 Federal St., Boston, Engrs.

Mass., Cambridge—C. T. Main, Engr., 201 Devonshire St., Boston, will soon award the contract for the construction of a 2 story, 86 x 134 ft. boiler house at the plant of Lever Brothers Co., 176 Broadway.

Mass., Medford—The Malden Electric Co., 201 Devonshire St., Boston, plans to build a 1 and 2 story, 58 x 62 ft. sub-station and office building on Salem St. Work will not be started until March, 1920. C. H. Tierney & Co., 201 Devonshire St., Boston, Engr.

Mass., Quincy—The city of Boston, Children's Institute Department, will soon award the contract for the construction of a 3 story, 95 x 115 ft. administration building at the Suffolk School for Boys on Rainsford Island. A steam heating system will be installed in same. Total estimated cost, $200,000. James Purdon, 8 Beacon St., Boston, Arch.

Conn., Bridgeport—The Board of Education will soon award the contract for the construction of a 2½ story, 118 x 130 ft. school addition on Kelsey St. A steam heating system will be installed in same. Total estimated cost, $155,000. F. A. Cooper, 1024 Main St., Arch.

Conn., Hartford—A. Steiger, 345 Main St., Springfield, Mass., is having plans prepared for the construction of a 90 x 150 ft. department store on Main and Pratt Sts. A steam heating system will be installed in same. Total estimated cost, $500,000. Buckman & Kahn, 56 West 45th St., New York City, Engr.

Conn., New Haven—A. C. Gilbert, Blatchey Ave., is having plans prepared for the construction of a 3 story, 80 x 100 ft. factory. A steam heating system will be installed in same. Total estimated cost, $80,000. Lockwood, Greene & Co., 101 Park Ave., New York City, Arch. and Engr.

N. Y., New York—The Board of Education, 500 Park Ave., New York City, received bids for installing heating and ventilating apparatus in Public School No. 6, Tremont Ave (Bronx Boro.), from Daniel J. Rice, 405 Lexington Ave., $61,393; E. Rutzler Heating Co., 404 East 49th St., $64,423; Gillis & Geoghagan, 537 West Broadway, $67,269.

N. Y., Brooklyn—The Borough of Brooklyn, Borough Hall, plans to build a public bath house in McCarren Park (Greenpoint). A steam heating system will be installed in same. Total estimated cost, $200,000. H. Bacon, 101 Park Ave., New York City, Engr.

N. Y., Flushing—The Knickerbocker Ice Co., 1480 Broadway, New York City, has awarded the contract for the construction of a 1 and 2 story, 120 x 140 ft. ice plant on Collins Pl., to Post & McCord, 101 Park Ave., New York City. Separate bids for installing heating system will be received. Total estimated cost, $150,000.

N. Y., Long Island City—C. E. Shepard, 311 Hudson St., will soon award the contract for the construction of a 3 story factory on Van Alst Ave. A steam heating system will be installed in same. Total estimated cost, $250,000. H. Balcom, 10 East 47th St., New York City, Engr.

N. Y., New York—The 145th St. Theatre Corporation, 120 Broadway, is having plans prepared for the construction of a 2 story, 88 x 172 ft. theatre and garage at 246-262 West 145th St. A steam heating system will be installed in same. Total estimated cost, $300,000. F. W. Lamb, 644 8th Ave., Arch.

N. Y., New York—The 75 Maiden Lane Corporation, c/o A. F. Gilbert, Arch., 80 Maiden Lane, will soon award the contract for the construction of a 12 story office building at 73-79 Maiden Lane. A steam heating system will be installed in same. Total estimated cost, $1,200,000.

N. Y., New York—The Advance Novelty Candy Manufacturing Co., 511 East 72nd St., plans to build a 5 story, 100 x 225 ft. factory on 138th St. and Willow Ave. A steam heating system will be installed in same. Total estimated cost, $500,000.

N. Y., New York—The Allerton House Corporation, 143 East 39th St., will build a 15 story, 100 x 200 ft. hotel, at 551-553 Madison Ave. A steam heating system will be installed in same. Total estimated cost, $1,000,000. Work will be done by day labor.

N. Y., New York—Belleview State Hospital, New York City, rejected all bids for the installation of a heating and ventilating systems in Fordham Hospital. Estimated cost, $15,000. Work will be readvertised.

N. Y., New York—The Broad Street Hospital, 127 Broad St., is having plans prepared for the construction of a 10 story, 45 x 75 ft. addition at 123-125 Broad St. A steam heating system will be installed in same. Total estimated cost, $300,000. W. N. Smith, 101 Park Row, Arch. and Engr.

N. Y., New York—The Commonwealth Construction Co., 18 East 41st St., will build a 200 x 300 x 200 x 350 ft. hotel on Broadway and 7th Ave., between 56th and 57th Sts. A steam heating system will be installed in same. Total estimated cost, $15,000,000. Work will be done by day labor.

N. Y., New York—B. S. Moss, 729 7th Ave., is having plans prepared for the construction of a 3 story theater and office building on 176th St., Carter, Tremont and Webster Aves., Bronx Borough. A steam heating system will be installed in same. Total estimated cost, $750,000. DeRosa & Pereira, 110 West 40th St., Engr. and Arch.

N. Y., New York—Oppenheim Collins & Co., 35 West 34th St., is having plans prepared for the construction of an 8 story, 50 x 100 ft. department store at 24 West 57th St. A steam heating system will be installed in same. Total estimated cost, $400,000. Buchman & Kahn, 56 West 45th St., Arch. and Engr.

N. Y., New York—The Victory Hall Association, 32 Nassau St., plans to build a 4 story, 197 x 400 ft. Memorial Hall on Pershing Square. A steam heating system will be installed in same. Total estimated cost, $5,000,000. G. W. Wingate, Arch.

N. Y., New York—The Western Import Co., 1457 Broadway, plans to build 38 stores and 1 theater on Simpson St., Westchester Ave. and Southern Blvd., Bronx Borough. Steam heating systems will be installed in same. Total estimated cost, $115,000 and $400,000, respectively.

N. Y., New York—Sam S. and Lee Shubert, 225 West 44th St., are having plans prepared for the construction of a theatre on 49th St., west of Broadway. A steam heating system will be installed in same. Total estimated cost, $500,000. Herbert J. Krapp, 116 East 16th St., Arch. and Engr.

N. Y., New York—The Victory Association, 32 Nassau St., is having plans prepared for the construction of a 4 story, 197 x 400 ft. hall on Pershing Square. A steam heating system will be installed in same. Total estimated cost, $10,000,000. Herts & Robinson, 331 Madison Ave., Arch. and Engr.

N. Y., Poughkeepsie—The Dutch Reformed Church is having plans prepared for the construction of a church. A steam heating system will be installed in same. Total estimated cost, $200,000. W. B. Chambers, 111 East 40th St., New York City, Engr.

N. J., Bordentown—The State of New Jersey plans to build a 1 story, 42 x 110 ft. trade school here. Two boilers will be installed in same. Total estimated cost, $20,000. F. H. Bent, 142 West State St., Trenton, State Arch.

N. J., Jersey City—The DesLauriers Column Mould Co., Woolworth Bldg., New York City, is having plans prepared for the construction of an 8 story, 100 x 200 ft. factory. A steam heating system will be installed in same. Total estimated cost, $400,000. Funk & Wilcox, Old South Bldg., Boston, Mass., Arch.

N. J., Trenton—The Y. M. C. A., 2 West 45th St., New York City, is having plans prepared for the construction of a new building, here. A steam heating system will be installed in same. Total estimated cost, $250,000. Jallade & Lindsey, 37 Liberty St., New York City, Arch. and Engr.

Pa., Chester—H. Childs Hodgens, Arch., 130 South 15th St., Philadelphia, will soon award the contract for the construction of a 2 story, 120 x 160 ft. theatre, dance hall and stores, for the Nixon Theatre Co., 52nd and Market St., Philadelphia. A steam heating system will be installed in same. Total estimated cost, $110,000.

N. J., Jersey City—The First National Bank, is having plans prepared for the construction of a 10 story, bank and office building on Exchange Pl. A steam heating system will be installed in same. Total estimated cost, $1,000,000. A. C. Bosson, 366 5th Ave., New York City, Engr.

N. J., Plainfield—The Y. M. C. A., 215 West 23rd St., New York City, is having plans prepared for the construction of a 3 story building. A steam heating system will be installed in same. Total estimated coat, $200,000. Jallade & Lendsey, 37 Liberty St., New York City, Engr.

Md., Baltimore—The Terminal Warehouse Co., Davis and Pleasant Sts., is having plans prepared for the construction of a 6 story, 120 x 600 ft. warehouse on Boston St., near Clinton St. Contract for lighting and heating will be sub-let. Total estimated cost, $300,000. Owens & Sisco., 1605 Continental Bldg., Arch.

Md., Baltimore—The Union Memorial Hospital Trustees are having plans prepared for the construction of a 4 story, 350 x 400 ft. hospital on 34th, 35th and Calvert Sts. and Guilford Ave. A steam heating system will be installed in same. Total estimated cost, $750,000. S. Rowland, Calvert Bldg., Chm. J. E. Sperry, 409 Calvert Bldg., Arch.

D. C., Washington—Duncan Candler, Arch., 753 5th Ave., New York City, will soon award the contract for the construction of a 7 story hotel for the War Council National Board of the Y. M. C. A., 341 Madison Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $800,000.

Ga., Columbus—The Merchants & Mechanics Bank, 1205 Broad St., had plans prepared for the construction of a bank building. A steam heating system will be installed in same. Total estimated cost, $150,000. Mowbray & Uffinger, 56 Liberty St., New York City, Arch. and Engr.

Ohio, Cleveland—The Erie Realty Co., Erie Bldg., has purchased a site at the rear of the Bangor Bldg., and plans to construct a 1 story, 78 x 150 ft. market house on same. A refrigerator plant will be installed in same. Total estimated cost, $150,000. Walker & Weeks, Euclid Bldg., Arch.

Ohio, Cleveland—The Euclid 17th Co., 214 Williamson Bldg., is having plans prepared for the construction of a 3 story, 124 x 176 ft. theater on East 17th St. and Euclid Ave. A steam heating system will be installed in same. Thomas W. Lamb, 1323 Euclid Ave., Arch.

Ohio, Cleveland—The W. S. Ferguson Co., Arch., 1900 Euclid Bldg., will receive bids until December 29 for the construction of an 8 story, 100 x 150 ft. garage on Huron Rd. and East 12th St. for the G. A. Tenbusch Realty Co., 1836 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $600,000.

Ohio, Cleveland—George A. Greible, Arch., Sloan Bldg., will receive bids about December 17 for the construction of a 6 story, 60 x 140 ft. commercial building at 640 Huron Rd., for the Huron Sixth Co., c/o of Architect. A steam heating system will be installed in same. Total estimated cost, $450,000.

Ohio, Cleveland—George D. Koch & Son Co., 10300 Euclid Ave., plans to build a 3 story, 60 x 180 ft. furniture store building on 100th St. and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $150,000.

Ohio, Cleveland—The Lake Shore Banking & Trust Co. has purchased a site on East 79th St. and Euclid Ave., and plans to construct a 3 story bank building on same. A steam heating system will be installed in same. Total estimated cost, $100,000. J. H. Jones, Osborn Bldg., Pres.

Ohio, Cleveland—The Plymouth Congregational Church, 3048 Chadbourne Ave., is having plans prepared for the construction of a 2 story, 100 x 200 ft. church on Drexmore Rd. A steam heating system will be installed in same. Total estimated cost, $250,000. C. S. Schneider, 2258 Euclid Ave., Arch.

Ohio, Cleveland—The Russ Co., 5511 Walworth Rd., manufacturer of beer pumps, is having plans prepared for the construction of a 4 story, 120 x 160 ft. factory addition. A steam heating system will be installed in same. Total estimated cost, $100,000. G. E. Rider Co., Century Bldg., Arch.

Ohio, Cleveland—T. H. Towell, Cadillac Bldg., is having plans prepared for the construction of a 2 story, 200 x 220 ft. sales and service building on East 21st St. A steam heating system will be installed in same. Total estimated cost, $300,000. H. E. Shimmis, 2031 Euclid Ave., Engr. and Arch.

Ohio, Cleveland—The Union Tire & Rubber Co., Hippodrome Bldg., is having plans prepared for the construction of a 3 story, 165 x 190 ft. rubber plant here. A steam heating system will be installed in same. Total estimated cost, $125,000. Osborn Engineering Co., 2848 Prospect Ave., Engr.

Ohio, Cleveland—F. W. Wallace, Citizens Bldg., plans to build a 14 story, 101 x 146 ft. office building on East 4th St. and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $1,500,000.

Ohio, Cleveland—The Wilbrand Co., 2031 Euclid Ave., plans to construct a 2 story, 150 x 200 ft. commercial building at 1910 East 21st St. A steam heating system will be installed in same. Total estimated cost, $250,000.

Ohio, Cleveland—The city will soon award the contract for furnishing one 20,000,000 gallon high service steam turbine, reduction gear driven centrifugal pump. Edward Shattuck, City Engr.

Ohio, Cleveland—The Board of Education will receive bids until December 29 for the construction of a 2 story, 98 x 156 ft. school addition on Warner Rd. One sectional cast heating boiler will be installed in same. Total estimated cost, $200,000. F. G. Hogan, Director of Schools. W. R. McComack, East 6th St. and Rockwell Ave., Arch.

Ohio, Cleveland—The city will receive bids until December 19 for the construction of twelve 8 x 50 ft. grit chambers, flow channels, pump wells and buildings for same, also for the installation of pipe and pump equipment, in connection with the proposed easterly sewage treatment works, foot of East 40th St. George Gascoigne, 618 City Hall, Engr.

Ohio, Cleveland—The City Ice Delivery Co. will receive bids after January 1 for the construction of a 1 story, 5000 ton ice storage plant, on Cedar and Lee Rds. Estimated cost, $100,000. Harry Novall, Cadillac Bldg., Pres. C. C. Coneby, Cadillac Bldg., Arch. and Engr.

Ohio, Cleveland—The Cleveland Railway Co., Leader News Bldg., is having preliminary plans prepared for the construction of a 1 story, 50 x 50 ft. automatic sub-station, on Detroit Ave. and West 65th St. Total estimated cost, $60,000. G. L. Radcliffe, Leader News Bldg., Gen. Mgr. L. P. Crocelius, 650 Leader News Bldg., Arch. and Engr.

Ohio, Cleveland—The Euclid East 46th St. Market House Co. plans to build a 1 story, 90 x 350 ft. public market house on Euclid Ave. and East 46th St. A steam heating system will be installed in same. Total estimated cost, $200,000. Charles Kamp, East 46th St. and Euclid Ave., Mgr.

Ohio, Cleveland—The May Co. plans to build a 2 story, 200 x 450 ft. department store addition on East 1st St. and Euclid Ave. The present steam heating plant will be extended. Total estimated cost, $400,000. Graham, Anderson, Propst & White, 80 East Jackson, Chicago, Ill., Archs.

Ohio, Cleveland—S. H. Strauss, 14505 Woodworth Rd., will receive bids about December 17 for the construction of two 2 story, 35 x 190 ft. hotels at Stop 113, Euclid Line. A steam heating plant will be installed in same. Total estimated cost, $140,000. Max Weis, 618 Union Bldg., Arch.

Ohio, Cleveland Heights (Warrensville P. O.)—The Board of Education will soon award the contract for the installation of three 250 hp. water tube boilers with stokers in the Lee Rd. School. E. K. Bryan, c/o Lee Rd. School, Engr.

Ohio, Dayton—L-C-R Storage Battery Co., North St. Clair St., plans to construct a 1 story, 70 x 150 ft. battery service station on Ludlow and Franklin St. Estimated cost, $75,000.

Ohio, Dayton—The Miami Ice Delivery Co., Ludlow Bldg., plans to build a 2 story ice manufacturing plant with 60 ton daily capacity and 5000 ton storage capacity, on 3rd St. Total estimated cost, $100,000.

Ohio, Fairport—The Board of Education will receive bids until December 23 for the construction of a 2 story, 84 x 126 ft. public school on 4th and Vine Sts. A steam heating system will be installed in same. Total estimated cost, $100,000. C. W. Bates, 701 National Bank Bldg., Wheeling, W. Va., Arch.

Ohio, Kent—The Board of Education is having plans prepared for the construction of a 3 story, 75 x 190 ft. high school. A steam heating system will be installed in same. Total estimated cost, $275,000. Mills & Millspaugh, Marshall Bldg., Cleveland, Engr.

Ohio, Lakewood (Cleveland P. O.)—The Board of Education is having preliminary plans prepared for the construction of two 3 story high schools. Steam heating systems will be installed in same. Total estimated cost, $600,000. P. T. Harrold, c/o Citizens Bank, Cleveland, Clk. C. W. Hopkinson, Rose Bldg., Cleveland, Arch.

Ohio, Silver Lake (Cuyahoga Falls P. O.)—The village received bids for the construction of two 1 story, 17 x 17 ft. pump houses, also furnishing deep well pumps, gate valves, etc., from the Gangl Construction Co., 2nd National Bank Bldg., Akron, $10,238; Aljer & Tillman, Guardian Bldg., Cleveland, $11,478.

Ohio, Steubenville—The Steubenville Bank & Trust Co. will soon award the contract for the construction of a 12 story, 53 x 195 ft. bank and office building on Main St. Two 300 h. p. boilers and 3 electric elevators with table and motors will be installed in same. Total estimated cost, $750,000. Peterson & Clare, National Bank Bldg., Arch.

Ohio, Warren—The General Fire Extinguisher Co. is having plans prepared for the construction of a 2 story, 100 x 200 ft. foundry. Electric motors to furnish power, blower, conveyor, etc., will be installed in same. Total estimated cost, $350,000. H. M. Lane Co., 701 Owen Bldg., Detroit, Engr.

Ill., Chicago—M. Born & Co., 540 South Wells St., is having plans prepared for the construction of a 12 story, 44 x 120 ft. addition to its clothing factory on Harrison and Wells Sts. An addition will be built to the present steam heating system. Total estimated cost, $850,000. A. S. Alshuler, 28 East Jackson, Arch.

Mich., Detroit—The City Water Board received bids for furnishing seven sets of revolving screens for low lift pumping station at waterworks, from the Link Belt Co., 732 Dime Bank Bldg., $26,400; the Chain Belt Co., 11th Ave. Viaduct, Milwaukee, Wis., $26,850.

Mich., Detroit—C. Howard Crane and E. G. Kiehler, Archs., Huron Bldg., will soon award the contract for the construction of a 2 story, 133 x 200 ft. theatre on Woodward Ave., for the Allen Theatre Enterprises, Richmond St., Toronto, Ont. A steam heating plant, to consist of boiler, fan, vacuum pump and accessories, will be installed in same. Total estimated cost, $1,000,000.

Mich., Detroit—The I. O. O. F. Lodge No. 373, c/o Peter Wilhemson, 1977 Kercheval Ave., has engaged Aaron H. Gould & Son, Archs. and Engrs., 811 Empire Bldg., to prepare plans for the construction of a 3 story lodge and club building on Kercheval Ave. Steam heating equipment will be installed in same. Total estimated cost, $250,000.

Mich., Detroit—The Jefferson Ave. Presbyterian Church, c/o C. McMath, Chm. of Bldg. Com., plans to build a 2 story church on Jefferson Ave. near Parkview Ave. Steam heating equipment will be installed in same. Total estimated cost, $500,000.

Mich., Detroit—The Odd Fellows Association, c/o Herman Kapp, 117 West Fort St., retained Andrew Clubb, Arch., Grebel Bldg., to prepare plans for the construction of a 3 story association temple on Wheeler and Lafayette Sts. Steam heating equipment will be installed in same. Total estimated cost, $120,000.

Mich., Flint—The Flint Council of Odd Fellows is having plans prepared for the construction of a 3 story, 66 x 116 ft. lodge house on Harrison and 4th St. A steam heating system will be installed in same. Van Leven, Schilling & Keough, 1115 Union Trust Bldg., Archs. and Engrs.

Mich., Pontiac—St. Michael's Parish, c/o Bishop Michael J. Gallagher, 31 Washington Blvd., Detroit, plans to construct a 2 story school, church and parish house on Chamberlain and Edison Sts. Steam heating equipment will be installed in same. Total estimated cost, $150,000.

Mich., Port Huron—A. Fraser, Military St., has purchased a site on Military and Pine Sts., and plans to construct a 4 story office building on same. A steam heating system will be installed in same. Total estimated cost, $100,000.

Mich., Port Huron—The Knights of Columbus, Military St., have purchased a site on Superior and Broad Sts., and plan to construct a 3 story, 100 x 130 ft. club house on same. A steam heating system will be installed in same. Total estimated cost, $100,000.

Wis., Chippewa Falls—E. G. Pannier & Son, 916 Prairie St., is having plans prepared for the construction of a 2 story, 130 x 200 ft. office building. A steam heating system will be installed in same. Total estimated cost, $125,000. Schlinz & Bailey, 63 West Jackson Blvd., Chicago, Arch.

Wis., Milwaukee—Cahill & Douglas, Engrs., Gross Bldg., are preparing plans for 200 hp. generator, about 60 motors, totaling 250-300 hp., and a prime mover, for Mueller & Son Co., 361 Canal St.

Wis., Milwaukee—The Walsh Harness Co., 425 East Water St., is having plans prepared for the construction of a 1 story, 60 x 200 ft. factory on Keefe Ave. A power plant will be installed in same. Total estimated cost, $60,000. M. Tullaren & Sons, 426 East Water St., Archs. and Engrs.

Wis., Milwaukee—George Ziegler Co., 362 Florida St., is having plans prepared for the construction of a 7 story, 80 x 115 ft. addition to its factory. The present steam heating system in same will be extended. Total estimated cost, $250,000. Brust & Philipp, Free Press Bldg., Archs. and Engrs.

Ia., Cushing—A. H. Bullock, Secy., of the Board of Education, is having plans prepared for the construction of a 3 story school. A steam heating system will be installed in same. Total estimated cost, $107,000. W. E. Hulse & Co., 210 Masonic Temple, Des Moines, Arch.

Ia., Des Moines—The city received bids for furnishing pipe and laying 32,256 ft. of sanitary sewer, also furnishing and installing a two-unit electrically operated centrifugal pumping plant, in connection with the proposed South Side sewerage system, from Alexander & Higbie, 2733 Sixth Ave., $178,346; National Construction Co., Davenport, $178,941; O. P. Herrick, 704 Observatory Bldg., $183,731.

Ia., Des Moines—The Executive Council of Iowa, State Capitol Bldg., will soon award the contract for furnishing and installing chain grate stokers, superheaters, stoker arches and soot blowers in the power and heating plant to be erected on the grounds of the Iowa State Capitol. R. E. Balea, Secy.

Ia., Odebolt—The town will soon award the contract for the construction of a sanitary sewerage system consisting of 1 flush tank, complete ejection outfit with pump and house, all appurtenances, etc. L. R. Bassett, Clk. W. E. Standeven, 619 Bee Bldg., Omaha, Neb., Engr.

Ia., Washta—J. K. McGonigae, Secy., of the Board of Education, is having plans prepared for the construction of a 3 story, 68 x 102 ft. school. A steam heating system will be installed in same. Total estimated cost, $100,000. W. E. Hulse & Co., 210 Masonic Temple, Des Moines, Arch.

Minn., Duluth—T. D. Whittler, Chn. of Bldg. Com., will receive bids until January 2 for the construction of a 2 story, 70 x 134 ft. church on West 2d St., for the Second Presbyterian Church, West Superior St. A steam heating system will be installed in same. Total estimated cost, $100,000. Halstead & Sullivan, Palladio Bldg., Arch. and Engr.

Minn., St. Paul—The Board of Education is having plans prepared for the construction of a 3 story, 160 x 239 ft., high school, to be known as Westside High School. A steam heating system will be installed in same. Total estimated cost, $250,000. C. A. Hausler, City Hall, Arch.

Minn., St. Paul—M. P. Ryan, owner of the St. Michael Hotel, 512 St. Peter St., is having plans prepared for the construction of a 10 story, 100 x 102 ft. addition to same. A steam heating system will be installed in same. Total estimated cost, $200,000. Mark Fitzpatrick, 17 West 9th St., Arch.

Minn., Richfield—Independent School District No. 143 is preparing plans for the construction of a 3 story, 57 x 174 ft. grade school with a 73 x 90 ft. wing. A steam heating system will be installed in same. Total estimated cost, $200,000.

Kan., Aurora—The city plans to construct a waterworks system, pumping plant, steel tank, etc. Total estimated cost, $30,000.

Kan., St. Francis—The city voted $55,000 bonds and is having plans prepared for the construction of an electric-light plant. The Henningson Engineering Co., National Bldg., 12th and Harney Sts., Omaha, Neb., Engr.

Neb., Hastings—The Masonic Cathedral Association is having plans prepared for the construction of a 4 story, 125 x 232 ft. masonic temple. A steam heating system will be installed in same. Total estimated cost, $500,000. Keffer & Jones, 204 Masonic Temple, Des Moines, Ia., Arch.

Neb., Omaha—The Baker Ice Machine Co., care of J. L. Baker, 19th and Nicholas Sts., plans to build a 2 story, 140 x 555 ft., office building and ice manufacturing plant. Total estimated cost between $350,000 and $400,000.

Mont., Hysham—The Hysham Irrigation District plans to irrigate 6,000 acres by means of pumping stations. Estimated cost, $250,000. B. C. Lillis, 239 Black Ave., Billings, Engr.

Mont., Missoula—The DeSmet Irrigation District plans to irrigate about 5,000 acres by constructing two pumping stations, each lifting water 70 ft. Estimated cost, $150,000. C. F. Farmer, 315 Tremont St., Engr.

Mo., St. Louis—The American Bakers' Machinery Co., Clinton and 9th Sts., is preparing plans for the construction of a 2 story, 100 x 300 ft., factory for the manufacture of ovens, on Kings Highway. A coke or oil burning power plant will be installed in same. Total estimated cost, $75,000.

Okla., Minco—The city voted $11,000 bonds to extend the waterworks system and improve the electric plant.

Wash., Centralia—The Sherman County Light & Power Co. is having preliminary surveys made for the erection of a steam plant adjoining the plant of the Eastern Railway & Lumber Co. Estimated cost, $150,000.

Ore., Astoria—The Port Commission plans to install an underground electric power system through port property, including construction of concrete transformer house, wires to carry 11,000 volts. Total estimated cost, $17,000.

Ore., Baker—The Oregon-Idaho Investment Co. has leased the claims adjoining the E. & E. mining plant and plans to install electric machinery, including hammer drills, etc. The company will also install a water power plant. Total estimated cost, $25,000. J. Arthur Baker, Mgr.

Ore., Portland—The Commission on Public Docks, foot of Stark St., plans to install one air compressor with a piston displacement of 44 cu. ft. per minute. C. B. Hegardt, Portland, Engr.

Ore., Portland—J. Jacobberger, Arch., Board of Trade Bldg., is receiving bids for the construction of a 4 story, 50 x 100 ft., club building on Park and Taylor Aves., for the Knights of Columbus. Separate bids for installation of plumbing and heating will be received. Total estimated cost, $100,000.

Ore., Portland—Multnomah County is having plans and estimates made by the Northwestern Electric Co. for the installation of new heating system in the court house here. Estimated cost, $25,000.

CONTRACTS AWARDED

N. H., Troy—The Troy Blanket Mills has awarded the contract for the construction of a 4 story, 68 x 289 ft. factory, 2 story, 64 x 224 ft. picker house and a small addition to boiler house, to E. D. Ward Co., 82 Foster St., Worcester, Mass. Total estimated cost, $350,000.

Mass., Boston—The Union Wool Co., 10 High St., has awarded the contract for the construction of a 7 story, 100 x 200 ft. storehouse on Summer St., to W. F. Kearns Co., Devonshire. A low pressure heating system will be installed in same.

Mass., Brookline—Daniel Fineberg, Scolloy Bldg., will build an 8 story, 75 x 116 ft. apartment house on Beacon St. A steam heating system will be installed in same. Total estimated cost, $225,000. Work will be done by day labor.

Mass., Fall River—The American Thread Co., foot of Kerr St., has awarded the contract for the construction of an addition to its boiler house, to the Aberthaw Construction Co., School St., Boston. Estimated cost, $40,000.

Mass., Fall River—The Baufora Spinning Co., 206 Globe Mills Ave., has awarded the contract for the construction of a 3 story, 120 x 350 ft. mill addition, to the New England Concrete & Construction Co., 201 Devonshire St. A steam heating system will be installed in same. Total estimated cost, $400,000.

Mass., Framingham—The Town School Commission has awarded the contract for the construction of a 2 story, 157 x 261 ft. school on Lincoln St., to C. S. Cunningham & Sons Co., 23 Central Ave., Lynn. A steam heating system will be installed in same. Total estimated cost, $160,000.

Mass., Springfield—The Cathedral St. Michael, Elliott St., has awarded the contract for the construction of a 2 story, 80 x 148 ft. high school, to Michael Maloney, 18 Bell Ave. A steam heating system will be installed in same. Total estimated cost, $175,000.

Mass., Worcester—St. Peter's Roman Catholic Church, 929 Main St., has awarded the contract for the construction of a 2½ story, 70 x 130 ft. school house on Main and Ripley Sts., to Michael Maloney, 8 Bell Ave., Springfield. A steam heating system will be installed in same. Total estimated cost, $125,000.

R. I., Pawtucket—The Collyer Insulated Wire Co., 249 North Main St., has awarded the contract for the construction of a 2 story factory on North Main St. to Fred T. Ley & Co., Inc., 499 Main St., Springfield, Mass. A steam heating system will be installed in same. Total estimated cost, $100,000.

N. J., Bayonne—The Board of Education has awarded the contract for the installation of heating and ventilating systems in the proposed Public Schools No. 1 and No. 4, to Gillis & Geoghan, 537 West Broadway, New York City. Estimated cost, $31,439, for each school.

N. J., Elizabeth—The Willys Corporation has awarded the contract for the construction of a 1, 2 and 4 story plant here, to Warren, Moore & Co., Colonial Bldg., Philadelphia. Estimated cost between $6,000,000 and $10,000,000. Contractors will sub-let power and heating systems.

N. J., Orange—The Orange Memorial Hospital has awarded the contract for the construction of a 4 story hospital addition to E. E. Paul Co., 101 Park Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $250,000.

N. J., Washington—The Globe Indemnity Co., 45 William St., New York City, will build a 6 story, 100 x 200 ft. office building on Washington St., here. A steam heating system will be installed in same. Total estimated cost, $400,000. Work will be done by day labor.

N. Y., New Rochelle—The Board of Education has awarded the contract for the construction of a 3 story grade school, to Emil Diebitsch, 383 Madison Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $300,000.

N. Y., New York—J. J. Astor, London, England, has awarded the contract for the construction of a 31 story, 66x98 ft. office building at 8-12 Wall St., to R. H. McDonald, 29 West 34th St. A steam heating system will be installed in same. Total estimated cost, $1,500,000.

N. Y., New York—The Banker's Trust Co., 16 Wall St., has awarded the contract for the construction of a 15 story office and bank building on 57th St., to R. H. McDonald, 29 West 34th St. A steam heating system will be inatalled in same. Total estimated cost, $400,000.

N. Y., New York—Louis Gold, 44 Court St., Brooklyn, will build a factory at 533 West 57th St. A steam heating system will be installed in same. Total estimated cost, $200,000. Work will be done by day labor.

N. Y., New York—The Montefeiro Home, 210th St. and Gun Hill Rd., has awarded the contract for the construction of a 5 story home, to Hegeman Harris, 33 West 42nd St. A steam heating system will be installed in same. Buchman & Kahn, 56 West 45th St., Arch. and Engr.

N. Y., Kings Park—The State Hospital Commission, Capitol, Albany, has awarded the contract for the installation of a steam heating system, in the proposed hospital for acute patients, at the Kings Park State Hospital here, to A. B. Barr & Co., 6 River St., Yonkers, $21,800. Noted Sept. 23.

N. Y., New York—The Board of Education, 500 Park Ave., has awarded the contract for the installation of a heating and ventilating system in Public School No. 147, to Hartel & Davis, 480 Clermont Ave., Brooklyn, $5437.

N. Y., New York—The United Odd Fellows Home, Havemeyer Ave., has awarded the contract for the construction of two 3 story, 50 x 75 ft. and 27 x 66 ft. dormitory buildings to J. A. Henderson, 30 East 42nd St. A steam heating system will be installed in same. Total estimated cost, $125,000.

N. Y., Portchester—The Mint Products Co., Inc., 299 Madison Ave., New York City, has awarded the contract for the construction of a factory to the Turner Construction Co., 244 Madison Ave., New York City. A steam heating system will be inatalled in same. Total estimated cost, $400,000.

N. Y., Staten Island—Fraser, Brace & Clark Dry Dock Co., Inc., 47 West 34th St., New York City, has awarded the contract for the construction of a ship repair plant, to consist of eight 1 story, 50 x 100 ft. buildings, to the Fraser, Brace & Co., Inc., 47 West 34th St., New York City. Steam heating systems will be installed in same. Total estimated cost, $1,800,000.

N. Y., Syracuse—Stewart F. Hancock, O. C. C. S. Bldg., has awarded the contract for the installation of a plumbing and heating system in the proposed 3 story, 67 x 130½ ft. office and loft building, on South Salina St., to W. George & Co., 122 North Warren St. Estimated cost, between $10,000 and $12,000.

N. Y., Thiells—F. A. Vanderlip, Pres. of the Board of Managers of Letchworth Village, 7 Wall St., New York City, has awarded the contract for installing heating systems in the proposed eight new buildings, to John C. Williams, Inc., Woolworth Bldg., New York City, at $132,872; electric work to Wheeler-Green Electric Co., 29 St. Paul St., Rochester, at $7677. Noted Aug. 19.

Pa., Philadelphia—The Stanley Company of America, 1214 Market St., has awarded the contract for the construction of a 1 story, 143 x 176 ft. theater building at 19th and Market St. to the Keystone State Construction Co., Franklin Bank Bldg., Philadelphia. A steam heating system will be installed in same. Total estimated cost, $1,000,000.

D. C., Washington—The Washington, Baltimore & Annapolis Electric Railroad Co. has awarded the contract for the construction of an 11 story, 200 x 200 ft. hotel and railroad terminal on 11th and 12th Sts. and New York Ave., to F. C. Lewin, 616 12th St., N. W., Washington, D. C. A steam heating system will be installed in same. Total estimated cost, $1,500,000.

Ohio, Cleveland—The Euclid 71st St. Co. has awarded the contract for the construction of a 3 and 4 story, 195 x 283 ft. garage and service building on Euclid Ave. and East 71st St. to Craig Curtiss Co., Guardian Bldg. Two sectional tube boilers and a blower fan system will be installed in same. Total estimated cost, $500,000.

Ohio, Cleveland—The Cleveland Automobile Co., East 131st St. and St. Claire Ave., has awarded the contract for installing a steam power plant (high pressure piping) in the proposed 4 story, 80 x 200 ft. factory on Euclid Ave. and London Rd. to W. G. Cornell Co., Leader News Bldg. Total estimated cost, $360,000.

Ohio, Cleveland—The Euclid-Windsor Co. has awarded the contract for the construction of a 2 story, 90 x 194 ft. garage and an 8 story, 90 x 200 ft. office building at East 46th St. and Euclid Ave. to Sam W. Emerson Co., 1900 Euclid Bldg. Steam heating and power plants, transformers, switchboards and motor generator will be installed in same. Total estimated cost, $2,000,000.

Ohio, Cleveland—The J. Guide Motor Lamp Co. has awarded the contract for the construction of 1 story, 120 x 500 ft. factory, including a boiler house on West 110th St. to the Crowell-Little Co., 1957 East 57th St. Two water tube boilers, feed pump and engine will be installed in same. Total estimated cost, $200,000.

Ohio, Cleveland—The Euclid East 46th Street Market House Co. has awarded the contract for the construction of an 11 story, 115 x 250 ft. market house on East 46th St. and Euclid Ave., to the Kamp Building Co., East 46th St. and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $200,000.

Ohio, Cleveland—The Marcus Loew Theatre Co., c/o Joseph Laronge, Mgr., 214 Williamson Bldg., has awarded the contract for the construction of a 4 story 125 x 175 ft. theatre on 17th St. and Euclid Ave., to the Fleischman Construction Co., 316 Permanent Bldg. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ohio, Cleveland—The Ohio Blower Co., c/o W. E. Clement, Secy., 9301 Detroit Ave., has awarded the contract for the construction of a 5 story, 65 x 300 ft. factory, to Sam W. Emerson Co., 1900 Euclid Bldg. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ohio, Dayton—The Maxwell Motor Co., Leo St., has awarded the contract for the construction of a 1 story, 45 x 60 ft. boiler house and a 100 x 120 ft. factory, to the Blanchard Building Co., Chapel Rd. Total estimated cost, $25,000.

Ill., Chicago—The Packard Motor Car Co., West Grand Blvd., Detroit, Mich., has awarded the contract for the construction of a 2 story, 298 x 304 ft. service and assembly station on West 37th St. and Princeton Ave., to Edward L. Scheldenheim, 111 West Monroe St., Chicago. Steam heating equipment, consisting of 2 boilers, air compressor and motor driven pump, will be installed in same.

Ill., Chicago—William Wrigley, Jr., 5 North Wabash Ave., has awarded the contract for the construction of a 16 story, 138 x 160 ft. office building at 400 North Michigan Ave., to the Languist & Illsley Co., 1100 North Clark St. A steam heating system will be installed in same. Total estimated cost, $2,000,000.

Ill., East St. Louis—Morris & Co., National Stockyards, will build a 2 story, 30 x 112 ft. power plant at the stockyards, here, and will be in the market for power equipment such as motors, generators, turbines, engines, etc. Total estimated cost, $75,000. Work will be done by day labor.

Ill., Urbana—The Wesley Foundation has awarded the contract for the construction of a 2 story, 150 x 170 ft. college, to English Brothers, Champaign. A steam heating system will be installed in same. Total estimated cost, $250,000.

Mich., Detroit—The Board of Education, 50 Broadway, has awarded the contract for installing heating, ventilating and plumbing systems in the proposed 2 story school, on Kenelworth Ave., to Irvine & Meier, 2289 Woodward Ave., $32,488.

Mich., Detroit—John Kalbfleisch, 293 Commonwealth Ave., has awarded the contract for the construction of a 2 story, 60 x 100 ft. laundry on McGraw Ave., to Harvey Zens, 471 Beddig St. A steam engine, boiler and generator will be installed in same. Total estimated cost, $45,000.

Mich., Grand Rapids—Berkey & Gay Co., Monroe Ave., have awarded the contract for the construction of a 6 story, 160 x 220 ft. factory and office building on Monroe Ave., to the Owen-Amea-Kimball Co., Michigan Trust Bldg., 42 Pearl St., Grand Rapids. Separate heating and power plant will be installed in same. Total estimated cost, $400,000.

Mich., Lansing—The Oldsmobile Division of the General Motors Corporation, Isaac St., has awarded the contract for the construction of a 4 story, 50 x 300 ft. administration building on Isaac and Logan Sts., to H. G. Christman Co., 302 Union Trade Bldg., South Bend, Ind. Steam heating equipment will be installed in same. Total estimated cost, $533,000.

Wis., Menomonee Falls—The Board of Education has awarded the contract for the installation of a steam heating system in proposed high and grade school, to W. M. Tuckwell, 86 Michigan St., Milwaukee.

Wis., St. Frances—The Nash Motors Co., Kenosha, has awarded the contract for the construction of a 1 story, 50 x 100 ft. power house, to the Northwestern Bridge & Iron Co., 32nd and Hopkins Sts., Milwaukee. Estimated cost, $75,000.

Ia., Winterset—The Board of Education has awarded the contract for installing plumbing and steam heating systems in the proposed 3 story, 82 x 140 ft. school, to Wallace & Linnane, 912 Walnut St., Des Moines. Estimated cost, $28,112.

Minn., Hibbing—The Oliver Mining Co., Wolvin Bldg., Duluth, has awarded the contract for the construction of a 4 story, 125 x 135 ft. hotel on Howard St., to C. F. Haglin Sons Co., Minneapolis. A steam heating system will be installed in same. Total estimated cost, $375,000.

Minn., Minneapolis—The Northern Bag Co., 101 3rd Ave., S., has awarded the contract for the construction of a 6 story, 150 x 300 ft. bag factory, on Washington Ave., N., to H. M. Leighton, 125 10th St., S. A steam heating system will be installed in same. Total estimated cost, $600,000.

Mo., St. Louis—The Board of Education, 9th and Locust Sts., has awarded the contract for the construction of a 3 story, 71 x 167 ft. school at 6017 Southwest St., to E. Gerhard, 615 Post Dispatch Bldg. A steam heating system will be installtd in same. Total estimated cost, $209,000.

Ore., Mt. Angel—St Mary's Parish, 345 4th St., Portland, has awarded the contract for the installation of a steam heating system in the proposed school building, to F. X. LeDoux, Henry Bldg., Portland. Total estimated cost, $100,000.

Ore., Salem—The state plans to install a circulating steam heating system in all the cells in the state penitentiary, here. Estimated cost, $2500. B. Olcott, Governor. Work will be done by convict labor.

Cal., Los Angeles—The Board of Public Service, 645 South Olive St., will build a 15 mile transmission line from here to San Pedro. A. C. Vroman, Secy. Work will be done by day labor.

Cal., Pasadena—The Board of Education has awarded the contract for installing a heating system in the proposed 2 story school building on the William McKinley School site, to Munger & Munger, 174 East Union St., $8127.

Ont., Hamilton—The Spectator Printing Co., James St., has awarded the contract for the construction of a 3 story, 60 x 100 ft. printing office and factory on James St., S., to Stewart & Sinclair, 17 Jackson St. A vacuum steam heating system will be installed in same. Total estimated cost, $100,000.

Ont., Walkerville—Hiram Walker & Sons have awarded the contract for the installation of one turbine driven unit with capacity of 5,000,000 imperial gallons per day, to the Turbine Equipment Co., 304 Excelsior Life Bldg., Toronto. Estimated cost, $26,000. Unit consists of two simple stage pumps, one connected to turbine by reducing gear, the other connected by magnetic clutch.

B. C., Port Coquittam—The Gregory Tire & Rubber Co., Standard Bank Bldg., Vancouver, will build a 3 story, 70 x 180 ft. factory and a 3 story, 60 x 80 ft. boiler house, here. Total estimated cost, $75,000. Work will be done by day labor.

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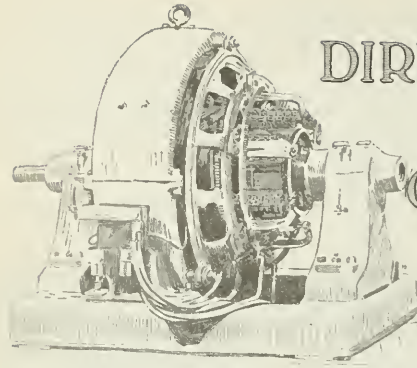

DIRECT-CURRENT MOTORS FOR DRIVING CENTRIFUGAL PUMPS

By

Nathan Wilkinson[*]

Their application in water works and other variable-speed service. Heavy starting torque and efficient methods of speed variation are desirable characteristics possessed by the direct-current motor.

THERE are many installations where only direct current is available, and hence the direct-current motor is the only solution to the power problem. There are other installations where an adjustment in speed is necessary, and in these cases the direct-current motor is peculiarly adapted. Induction and synchronous motors are essentially constant-speed machines, and furthermore, the speeds are limited. For a 60-cycle installation the synchronous speeds are 1800, 1200, 900, 720, etc. On the other hand, the direct-current motor can be designed for any definite speed, and this speed can be increased or decreased by a corresponding change in the voltage at the armature terminals, or if the voltage is constant, the speed can be increased by weakening and decreased by strengthening the shunt field or by inserting resistance in the armature circuit.

To show the desirability of adjustable speed for centrifugal pumps in certain cases, a short review of its characteristics is necessary. In the article by T. M. Heermans on "Horsepower Requirements of Centrifugal Pumps," published in *Power*, May 20, 1919, the following paragraph appears:

> The amount of useful work done is known as the water horsepower and is equal to the weight of water lifted a certain number of feet in a definite length of time. Since pump capacity is usually expressed in gallons per minute (g. p. m.), and a gallon of water weighs $8\frac{1}{3}$ lb.,
>
> $$\text{Work done per minute} = g.p.m. \times 8\tfrac{1}{3}\ lb. \times feet\ head$$
>
> and as one horsepower is equivalent to lifting 33,000 lb. one foot in one minute, water horsepower,
>
> $$W.hp. = \frac{g.p.m. \times 8\frac{1}{3} \times feet\ head}{33{,}000} = \frac{g.p.m. \times feet\ head}{3957}$$
>
> In the preceding formulas the head not only consists of the height the water has to be lifted, but also includes the head lost by friction in the piping and the head required to make the water flow through the piping at a given rate; that is, the total head equals the static lift plus pipe friction plus velocity head.

A centrifugal pump operated at a definite speed develops a definite head. A decrease in speed reduces the head, and an increase in speed raises the head. Since the gallons per minute are determined by the head required to make the water flow through the piping at a given rate—that is, the velocity head—and since the total head equals the static lift plus pipe friction plus velocity head, it is apparent that, for a given total head—that is, given speed of pump—an increase in the static lift or pipe friction will cause a decrease in the velocity head and thus a decrease in the quantity of water delivered.

An increase in the static head or pipe friction will also reduce the horsepower required from the motor, and to deliver the required gallons per minute it is necessary to increase the speed of the pump to obtain the required increase in velocity head.

On the other hand, a decrease in static head or pipe friction will increase the velocity head and thus increase the gallons per minute and, consequently, increase the horsepower required from the motor. In this case it is necessary to reduce the speed of the pump and thus reduce the volume of water and the load on the motor. It is therefore apparent that where it is necessary to operate a centrifugal pump at different static heads of different lengths of piping, a direct-current motor is better adapted for the work than either an induction motor or a synchronous motor.

Where the voltage is constant, either the shunt-wound or compound-wound direct-current motor can be successfully used in starting and operating centrifugal pumps. In most cases the ordinary starting box is required. Where slight speed adjustment is necessary, a starting box permitting of a small decrease of the shunt-field ampere-turns is required. For a large speed adjustment where the power required by the centrif-

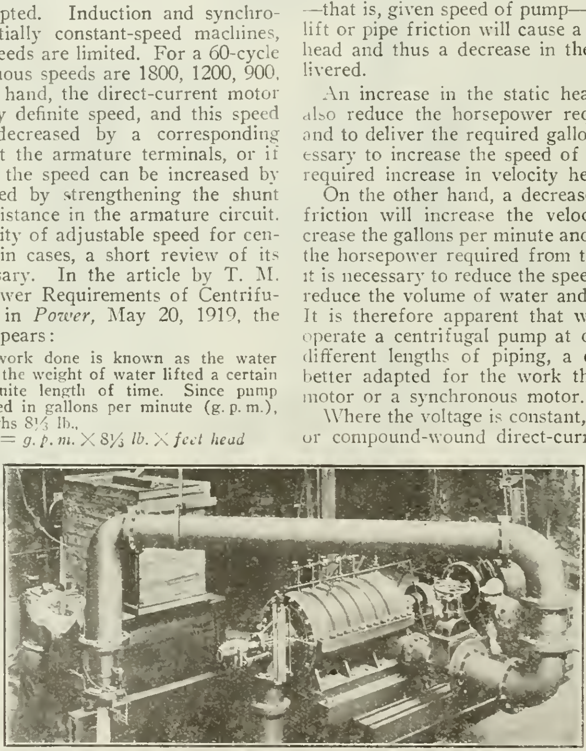

FIG. 1. MOTOR-DRIVEN SIX-STAGE CENTRIFUGAL PUMPING UNIT UNDER TEST

ugal pump drops off rapidly with the decrease in speed, the starting box and speed regulator are arranged to reduce the speed below the normal speed of the motor by insertion of armature resistances and to increase the speed above normal by field weakening. Where the voltage is variable, as is sometimes the case with temporary installations, especially when fed from an electric-railway circuit, a compound direct-current motor should be used for the reason that an increase in voltage adds to the speed of a shunt motor, thus increasing the velocity head and overloading the motor. With a compound-wound motor an increase in load decreases the speed, which partly compensates for the increase in speed due to increase in voltage. Hence there is less variation in speed and head due to variation in voltage in a compound motor than in a shunt motor. However, the characteristics of a direct-current motor, whether it is a shunt- or compound-wound, are such that a slight speed adjustment is desirable for centrifugal pump drive for the following reason:

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[*] Electrical Department, Allis-Chalmers Manufacturing Company.

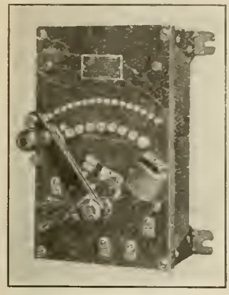

FIG. 2. STARTING BOX FOR SHUNT-FIELD CONTROL

A direct-current motor will run at a lower speed when it is cold than when it is hot, because its shunt-field windings have less resistance when cold and consequently allow more current to flow through them. This of course strengthens the field magnetism and lowers the speed of the motor. The speed is not lowered in inverse proportion to the field strength owing to the fact that the internal resistance of the motor is also lower when cold, which tends to increase the speed of the motor, but in most cases the field strengthening more than offsets the effect of the cold internal resistance and the motor runs at a lower speed when cold then when hot. The time required for the shunt fields to reach their maximum or operating temperature varies from two to six hours, depending on the size and characteristics of the motor. In the meantime the pump will operate at a speed somewhat below normal and its capacity will be reduced. In fact, the writer knows of one case where the speed was lowered to such an extent that the pump did not discharge any water at all until the motor heated up and reached its normal speed. Of course, this would occur only where the friction head was low in proportion to the total head.

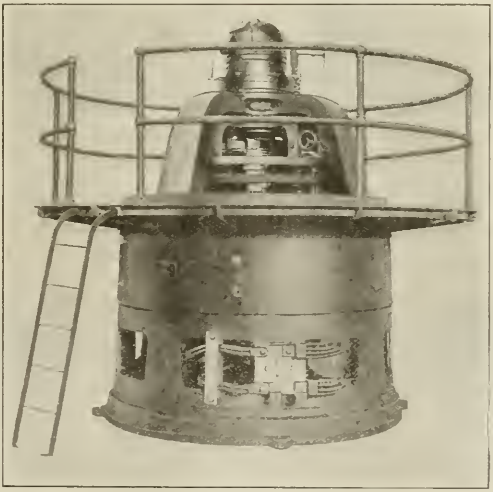

FIG. 4. LARGE VERTICAL DIRECT-CURRENT CENTRIFUGAL-PUMP MOTOR

In the case cited the difficulty was overcome by putting a rheostat in the shunt fields of the motor so that the speed could be brought up to normal at all times. This rheostat should be supplied with every direct-current-motor-driven pump. It can be combined with the starting box as in Fig. 2.

A city water-works plant is an admirable application of direct-current motor drive for centrifugal pumps. For domestic service the pump has to supply water at a constant pressure and variable capacity. To meet this condition the pump speed must vary, since the friction head varies with the amount of water used. The speed variation can be automatically secured by placing a rheostat in the motor-field windings and operating it directly from a pressure regulator, and the water pressure maintained constant regardless of the amount of water used. If a high pressure is desired for fire service, another regulator can be cut in by means of a throw-over switch and a higher pressure maintained.

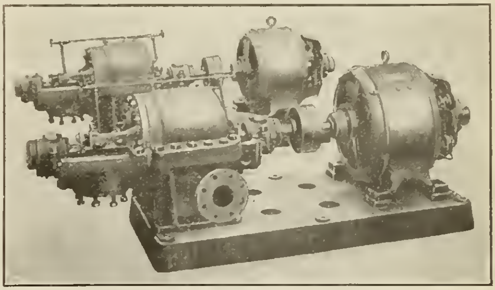

FIG. 3. MULTI-STAGE PUMPS DIRECT-CONNECTED TO DIRECT-CURRENT MOTOR

With constant-speed motors the usual method resorted to is to have two pumps and run them in parallel for domestic service and in series for fire service. This, of course, gives more water for domestic use than for fire service, which is just the opposite to what is desired because the fire demand may come just when the domestic demand is greatest. A variable-speed pump, therefore, more nearly approaches the condition desired.

Another application peculiarly suited for direct-current motors is dock service, where a constant capacity at a variable head is required and can be secured by using a variable-speed motor. In summing up it can be stated that outside of a few special cases, such as submerged motors, etc., the direct-current motor can be used for driving centrifugal pumps wherever induction or synchronous motors can be used. In addition to having all the desirable characteristics of the alternating-current motor, it has an inherently heavy starting torque and a more efficient method of speed variation than either of the other types.

The low-grade bituminous coals available for fuel in this country vary in heat value from 8000 to 9000 B.t.u., where the high-grade coals vary from 14,000 to 15,000 B.t.u.

Burning Lignite on Forced-Draft Chain Grate

By H. F. GAUSS*

Lignite containing 33 per cent. moisture dried in induction zone at front of stoker. With grate to heating surface ratio of 1 to 43 obtained at fair efficiency 125 per cent. of normal boiler rating. Maximum rate of combustion 40 lb. of fuel per square foot of grate area.

COMPARATIVELY few engineers have been called upon to burn lignite under boilers. It is safe to say that only those located in the immediate vicinity of lignite mines have had occasion to use it so. Much work has been done, however, by furnace designers and stoker companies in an endeavor to develop a means of burning lignite efficiently and in sufficient quantities to make the fuel suitable to the modern boiler room. Efforts so expended have not been in vain, and the time is fast coming when lignite will be recognized as a desirable fuel for the cheap generation of power.

The writer recently had an opportunity to conduct some experiments in burning lignite on the Illinois forced-draft chain-grate stoker. In conducting this work the object in view was to burn this fuel as received without any attempt to dry it out or prepare it especially for burning. Practically all previous attempts to burn lignite have been made on fuel that has been stored outside for several months and thus allowed to lose most of its moisture. In this work, however, the lignite was unloaded directly from the cars in which it was received from the mines, crushed to about 1½-in. size and fed into the stoker hopper. An approximate analysis of the fuel used was as follows:

Moisture, per cent	33.07
Volatile combustible matter, per cent	29.83
Fixed carbon, per cent	26.77
Ash, per cent	10.33
British thermal units, dry basis	10,599
British thermal units, original basis	7,094

It was anticipated that the difficulty of igniting a fuel containing so great a percentage of moisture would be overcome by the use of a special induction zone at the front of the stoker. As brought out in the previous description, this induction zone consists of a tuyere constructed exactly as the blowing tuyeres, but connected with an exhaust fan which draws some of the gases from the furnace down through the green fuel under the ignition arch.

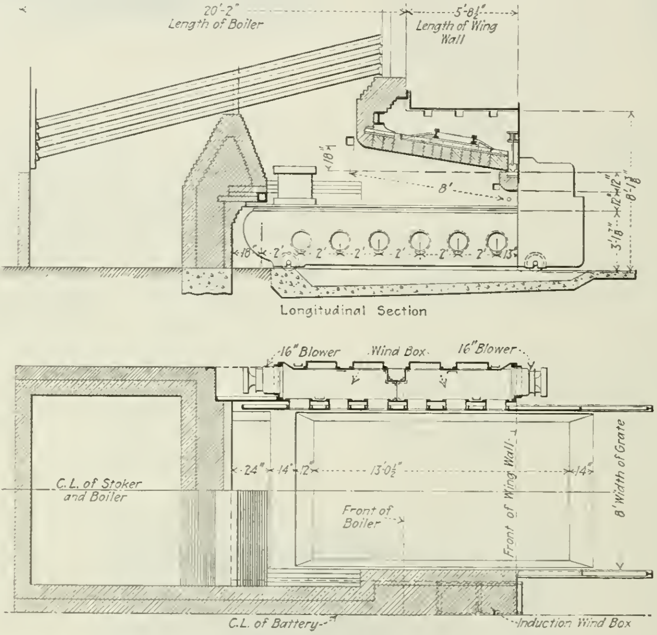

FIG. 1. SETTING FOR FORCED-DRAFT CHAIN GRATE UNDER 450-HP. BOILER

Fig. 1 shows the layout of the stoker. It was at first thought desirable to discharge the induction fan into one of the pressure tuyeres as is done when burning higher grades of coal. So much moisture collected in this discharge, however, that it was decided to pipe it directly into the smoke-stack. Careful analysis of the gases thus discharged showed 3 to 4 per cent. of CO_2 and no CO. The temperature was high and no doubt some

FIG. 2. FRONT VIEW, SHOWING LAYOUT OF STOKER

FIG. 3. SIDE VIEW WIND BOX, SHOWING 16-IN. BLOWER

FIG. 4. INDUCTION WINDBOX AND DISCHARGE PIPE TO STACK

loss was sustained from this cause, but the gain in prompt ignition more than offset the loss. After connecting the discharge from the induction fan into the stack, it was found that the stack suction alone was sufficient to maintain ignition and the induction fan was necessary only for starting up.

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*Chief Engineer, Illinois Stoker Company.

Figs. 2, 3 and 4 are photographic reproductions of the installation. Figs. 2 and 3 show the windbox and one of the 16-in. blowers used to supply air to the stoker. Another 16-in. blower is similarly situated at the other end of the windbox. A partition at the middle of the box permits the two fans to operate independently of each other.

In Fig. 4 is shown the induction windbox on the opposite side of the stoker and the discharge pipe leading to the stack. The stains on this pipe were caused by water trickling down through the joints. The moisture, withdrawn from the fuel during ignition, had condensed in the discharge pipe. The induction fan is placed inside of the windbox, being supported in a partition in the box. It takes its suction from the first tuyere and discharges into the pipe leading to the stack.

An action peculiar to chain-grate stokers was observed, especially in attempting to burn lignite that had dried out and thus lost much of its moisture. The fuel in this condition ignited freely and burned well for the first few feet of grate travel. The ignition, however, did not penetrate to the bottom of the fuel bed, and a little brittle crust formed over the entire surface of the fuel bed, which interfered seriously with combustion.

After experimenting it was found that wetting the fuel before firing eliminated this trouble. It is known that the successful operation of any chain-grate stoker depends to a large extent upon providing the proper amount of moisture in the fuel. Illinois bituminous coal burns best when the free moisture in it is between 15 and 20 per cent. It was not to be expected that lignite would require any additional moisture, but the results of these experiments established the fact that it does. About 5 per cent, of water was added before the fuel was fired, and the action appeared to be a breaking up of the fuel bed as the combustion progressed, owing to the explosion of the steam generated in the fuel bed. The crust of fused ashes on top did not form, and ignition penetrated to the bottom of the bed.

The work has not been carried to completion, but thus far no trouble has been experienced in obtaining from 100 to 125 per cent. of normal rating at a fair efficiency. Higher ratings can be secured by providing more grate surface. The water-tube boiler used in the tests was rated at 450 hp. The grate was 8 ft. wide by 13 ft. long, containing 104 sq. ft. of surface, including the induction zone. The maximum rate of combustion was 40 lb. per sq. ft. of grate area.

Efficient Operation of Power Plants

By F. C. TORRANCE

The writer tells how to go about plotting curves of boiler, turbine and auxiliary performance, and station performance, so that the plant may be at all times operated at the highest efficiency for the load carried.

IN THE design of a modern station, the gages for guiding operation are, in their way, just as important as the main units. For example, the boilers are equipped with air-pressure gages for forced draft; draft gages, both furnace and under damper; thermometers for water and steam temperatures; and either meters for measuring the water fed to each boiler or flow meters for recording the steam discharged from each boiler. A good many stations also supply their firemen with CO_2 recorders for further checking combustion. In the turbine room the steam fed to each turbine is measured, as well as the pressure and temperature of the steam. In this way the engineer has a constant check on the performance of the station and can constantly check the operators.

How to Use the Instruments

How shall they be used? Before the engineer in charge can direct his men as to the points at which the different boilers should be banked, or the main units and auxiliaries cut in or out of service, he must first determine this for himself. Of course, the only way to accurately obtain this information would be to run tests on all the different types of apparatus and from these results direct the operation of the station. This would take several months, and some steps should be taken to operate as efficiently as possible during the time that the tests are being run.

The easiest way to accomplish this is to take the manufacturers' guarantees as a basis for calculation. In the newer stations, where these guarantees are all available, this should be a fairly simple matter.

As an example, assume a station with a 24-hour load curve similar to that shown. This station has eight boilers, each of 11,400 sq.ft. heating surface, and three 20,000-kw. turbines for carrying the load, but all the boilers and turbines are not needed at all hours of the day. The boilers have multiple-retort underfeed stokers. The first consideration is whether the station units (boilers, turbines and auxiliaries) are being operated in such a way as to give the best water rate on the station and at the same time carry the boilers at their best rating.

The station in question is equipped with steam-driven auxiliaries, the exhaust from which, in excess of that required for the economizers, is fed into one of the lower stages of the main turbine, so that none is wasted. The problem, then, is to determine the total station water rate for this 24-hour load, and having determined it, a study of the operation can be made with a view to cutting the units on and off the line at such points as would give the best station water rate and efficiency.

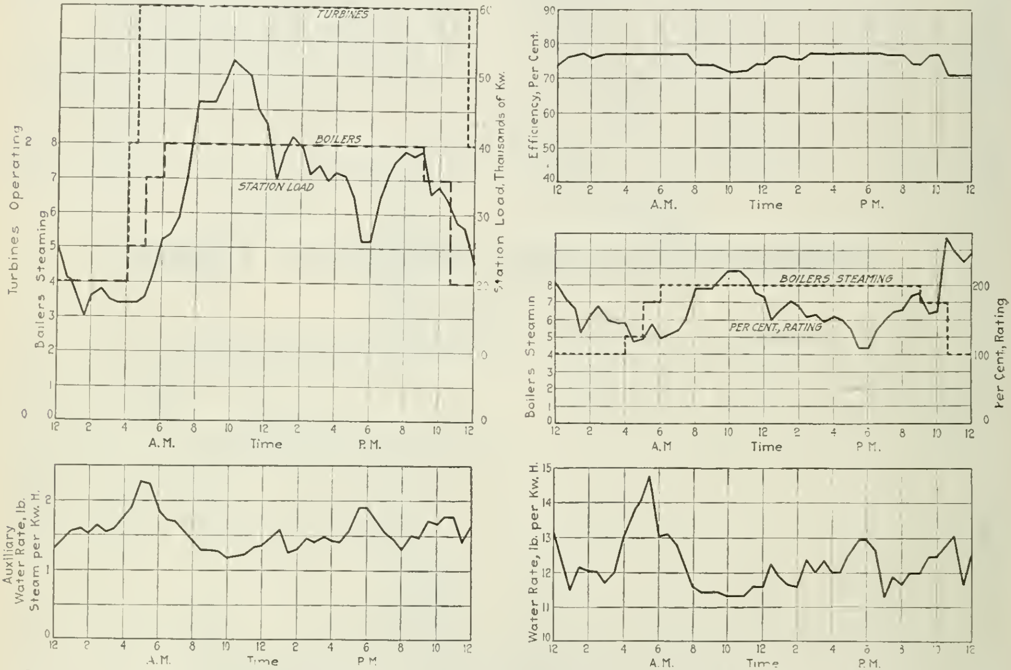
This station is equipped with surface condensers, hotwell pumps, circulating pumps, wet air pumps, boiler-feed pumps, house-service pumps and forced-draft fans. All the pumps and fans are turbine-driven.

Water-Rate Curves

Before proceeding further, guarantee curves for this apparatus must be drawn. Knowing the load at each hour of the day and the different units operating, it is a comparatively simple matter to draw up water-rate curves, not only for each individual unit, but for the entire station. This is done and is shown for the main units and for the auxiliaries, while a combined water-rate curve also is shown.

One of the first points to be noticed after inspecting the results is the fact that the second main unit was started up too soon in the morning. This is evident after inspecting the different curves. The first additional machine was started fully one hour before needed, allowing half an hour for variation in load, and the third machine was put on the line two hours and a half too soon. This is shown where the station load and curves of boilers and turbines operating are plotted. It is also shown on the water-rate curve for the main units and also on the water-rate curve for the entire station.

A study of these curves shows that the station water rate increased excessively at approximately 4 o'clock in the morning, at which time the second machine was being started, and the water rate did not get back to normal until 8 o'clock. If the second unit had not been put on the line until 5 o'clock and the third until 7 o'clock—which would have given ample time—this increase in water rate could have been largely done away with, and the average station water rate would have been somewhat lower.



SHOWING VARIOUS CURVES PLOTTED TO DETERMINE EFFICIENT RELATION BETWEEN LOAD AND EQUIPMENT IN SERVICE

Another point to be considered in this connection is the boiler operation; that is, whether the different boilers are operated so as to give the best results. A combined operating, rating and efficiency curve for the boilers is shown and indicates that the boiler operation was nearly normal, with the exception of the period from 10 p. m. to midnight, at which time the units were taken off the line too rapidly.

The foregoing results, of course, are based upon manufacturers' guarantees, and while they are likely accurate to a reasonable degree, they should be checked up with tests of the actual performance of the various apparatus, after which an accurate performance curve could be worked up and followed.

These results clearly show that too much care cannot be taken in starting and stopping the equipment of a station. The station equipment must be carried at its most efficient load at all times, and at the same time care must be taken that the combination of boilers and turbines operating is flexible enough to care for any reasonable increase in load. This can be done with a great degree of accuracy after the operator has made a study of the station-load curves for the various seasons of the year.

Having determined these conditions for himself, the engineer should instruct the operators, so that the station may be run at all times at greatest efficiency. This can be helped further by posting the results of station performance from day to day, so that the men may know at all times just what they are doing. This will increase interest and cause a friendly rivalry between the shifts, which will undoubtedly tend toward better results all around.

Correction—It has been pointed out by the Hagan Corporation, Pittsburgh, that the article appearing in the Oct. 21 issue of *Power*, pp. 610-11, describing the Hagan Combustion Control Regulator, may give the impression that the chart was taken from a stoker windbox. Such was not the case. The chart was drawn by a pen attached to the chain connection from a Hagan Master Regulator to a damper in the stack. The article stated that the chart showed a movement of the Hagan Roto Valve, while in reality it indicated the movement of the Hagan Regulator during a 24-hour period, and the notations "Inches Water Gage" on the chart were reproduced through an error.

Gas Measurements with Plain Orifices

By A. H. BLAISDELL

Directions for using orifices for the measurement of the flow of moisture-laden gases. Gives a formula for such use with a curve showing coefficients and a drawing of the necessary arrangement of the apparatus when these coefficients are applied. An illustrative problem is solved and the result compared with that from the simpler dry-gas formulas.

THE plain orifice, either with sharp-edged or rounded entrance, has become a standard means of measuring rate of gas flow, and when properly installed and calibrated, offers a very convenient and accurate method for such measurements. Much experimenting has been carried out in order to determine discharge coefficients for orifices under different conditions of flow, and simplified formulas have been developed with which these coefficients might be used. These formulas are fairly satisfactory when used with bases containing only a small amount of moisture, but since in most cases the moisture content is large, it seems desirable to develop a formula which will, when used in connection with a plain orifice, give reliable values for the rate of flow of dry gas regardless of the amount of water vapor in the gas.

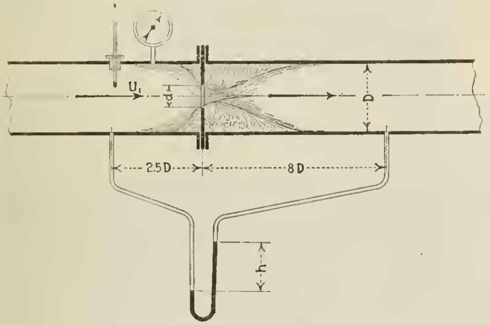


FIG. 1. ORIFICE APPARATUS FOR MEASURING GAS FLOW

The sharp-edged orifice or throttle-disk can be easily located in a pipe line by being slipped in between flanges, as shown in Fig. 1. The disk causes "wiredrawing" or "throttling," resulting in a drop of pressure, the drop increasing with the rate of discharge. In the high-pressure region, or upstream side of the disk, the gas flows with a velocity U_1. As it passes through the orifice into the low-pressure region, the velocity increases, but this increased velocity is not maintained since the energy of the jet is dissipated when the gas flowing through the orifice enters and mixes with the gas in the low-pressure region. Eddies are produced, and the increase of kinetic energy is returned to the fluid in the form of heat.

CERTAIN PROPERTIES OF VARIOUS GASES

	Molecular Wt. (M^a) of Gas	Wt. per Cu. Ft. at 62° F. and 14.7 Lb. per Sq. In.	Gas Constant R
Air	28.95	0.0761	53.34
Methane (CH_4)...............	16.02	0.0421	96.31
Ammonia (NH_3)	17.06	0.04483	90.50
Carbon dioxide (CO_2)..........	44.00	0.1156	35.09
Carbon monoxide (CO).......	28.00	0.0734	55.14
Hydrogen (H_2)	2.016	0.00529	765.86
Oxygen (O_2)	32.00	0.0840	48.25
Nitrogen (N_2)	28.08	0.0737	54.99
Water (H_2O).................	18.02	......	.....

For small pressure differences, say up to 2 per cent. of the absolute gas pressure, it is permissible to assume the gas density as being practically constant. In that case it is easy to show that the weight of dry gas flowing through a throttle disk in pounds per second is

$$W = \frac{0.0125\,C\,d^2}{R_g} P_g \sqrt{h\delta \quad \frac{R_m}{P_m\,T}} \tag{1}$$

where

W = Pounds per second of dry-gas;
C = Velocity coefficient;
d = Diameter of orifice in inches;
P_g = Partial pressure of the dry gas in pounds per square inch absolute;
R_g = Gas constant for dry gas;
h = Differential in inches (see Fig. 1);
δ = Density of liquid in differential gage;
R_m = Gas constant for mixture of gas and vapor;
P_m = Combined or total pressure of mixture in pounds;
T = Temperature of mixture in degrees F. absolute.

The results of very carefully conducted tests[1] have indicated that the coefficient C varies with the ratio of the orific diameter to the pipe diameter, and values of C from these tests are plotted in Fig. 2. When using these values in actual tests, it must be remembered that part of the pressure drop occurs in the pipe and consequently the distance of the differential gage openings from the throttle disks must be proportional to those used in the calibration; therefore, the values given by the curve of Fig. 2 can be used only when the gage openings are located as indicated in Fig. 1.

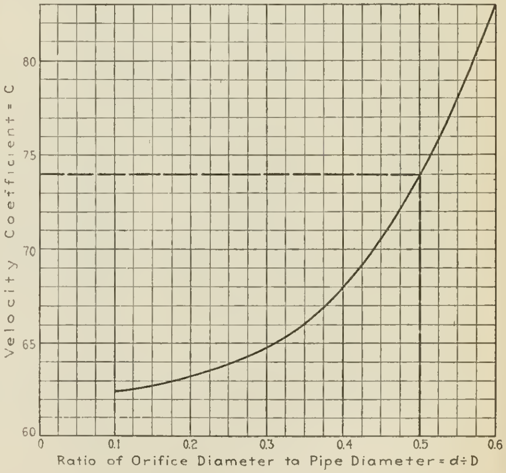


FIG. 2. VELOCITY COEFFICIENT FOR GAS ORIFICES

The accuracy of formula (1) is affected to some extent by the magnitude of the velocity U_1, or the velocity of approach. However, if the ratio of the orifice diameter to pipe diameter does not exceed 0.5, then the effect of U_1 can be neglected. It should be noted that this formula gives dependable results only when the gas flow is steady. For heavy pulsations the volume discharged is proportional to the average velocity, whereas h, in the formula, is proportional to the average velocity squared.

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[1] See "Zeit. des Ver. d. Ing.," Feb. 23, 1908, and the "Jour. A. S. M. E." for March, 1916.

In order to use formula (1) it is necessary that there be some means of obtaining accurate values for P_m, T, P_g and R_m. P_m can, of course, be determined by use of a pressure gage or a mercury column, located either on the upstream or downstream side of the throttle disk, but not closer than the openings for the differential-gage connections. If the moisture condition of the gas is to be considered, then the temperature T $(= t + 460)$ is the dry-bulb reading of a wet- and dry-bulb thermometer inserted in the pipe in close vicinity to the pressure gage. The partial pressure P_g of the gas can be calculated provided the relative humidity of the mixture of gas and vapor is known. In that case we have

$$P_g = [(\textit{gage pressure} + B) - kp] \qquad (2)$$

where

k = Relative humidity;

p = Vapor pressure for saturated vapor at temperature T degrees absolute;

B = Barometric pressure in pounds per square inch absolute.

The relative humidity is most easily obtained from a humidity chart such as that of Fig. 3. The value of p can be found in any steam tables and is the absolute pressure in pounds per square inch corresponding to the absolute temperature T. Values of kp for gas temperatures ranging from 100 to 200 deg. F. and relative humidities from 10 to 100 per cent., can be secured directly from the curves of Fig. 4. The barometric pressure in inches of mercury can most conveniently be obtained by means of an aneroid barometer. Ordinarily, it will be all right to assume $B = 14.7$ lb. per sq. in. abs. The gas constant R_g is known for the gases dealt with in engineering practice. The gas constant R_m for the mixture can be figured from

$$R_m = \frac{1544\, P_m}{\left[M_g\,(P_m - kp) + M_v\left(\frac{kp}{P_m}\right)\right]} \qquad (3)$$

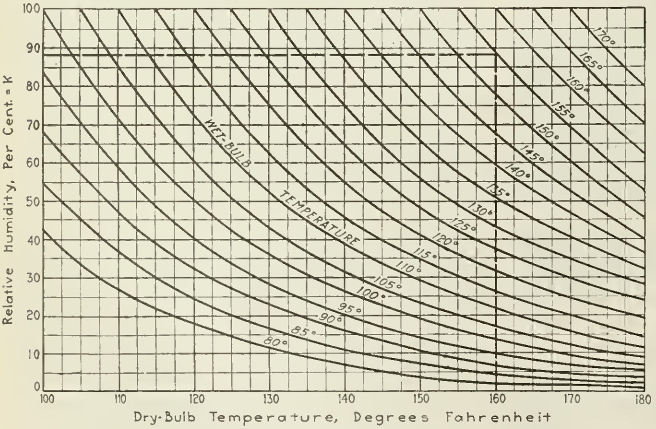


FIG. 3. CHART FOR DETERMINING RELATIVE HUMIDITY

where M_g and M_v are the molecular weights of the gas and the vapor, respectively. (See accompanying table.)

If air is the gas to be measured and the differential h is measured in inches of water, then formula (1) reduces to

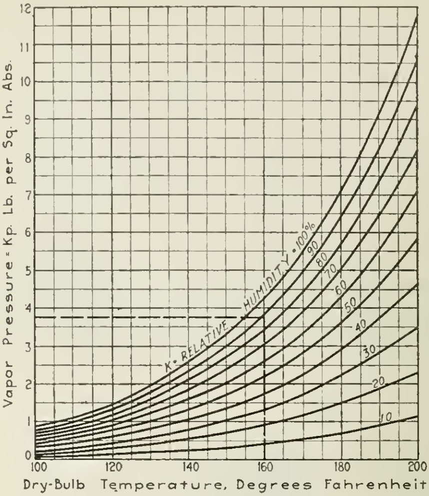


FIG. 4. VAPOR PRESSURES IN VAPOR AND GAS MIXTURES

$$W = 0.00181\, C\, d^2\, P_g \sqrt{\frac{h\, R_m}{P_m\, T}}\ \textit{lb. per second}$$

For gas pressure of 25-lb. gage or less, it is best to use a mercury column instead of a low-pressure gage, since the mercury column offers a far more accurate method of pressure measurement than that furnished by any pressure gage.

Illustrative Problem: Suppose air is being delivered through a 4-in. pipe line under a pressure of 100 lb. per sq. in. gage. A 2-in. diameter orifice is inserted into the line in accordance with the foregoing directions. If the pressure drop through the throttle disk is 10 in. of water and the temperatures of the wet-bulb and dry-bulb thermometers are 155 deg. F. and 160 deg. F., respectively, and the barometric pressure $B = 14.7$ lb. per sq. in. abs., what will be the rate of discharge in pounds per second of dry air:

Referring to Fig. 2 we find that for $\frac{d}{D} = \frac{1}{2}$ $C - 0.74$. From the humidity chart, Fig. 3, for a dry-bulb temperature of 160 deg. and a wet-bulb temperature of 150 deg. the relative humidity is given as 89 per cent. Now, referring to the curves of Fig. 4, we find that a dry-bulb temperature of 160 deg. and a relative humidity of 89 per cent., that the vapor pressure kp is about 3.8 lb. per square inch absolute.

Therefore, the partial pressure P_g of the dry air is

$$(100 + 14.7) - 3.8 = 110.9\ \textit{lb. per sq. in. absolute}$$

$$\text{Constant } R_m = \frac{1544 \times 114.7}{29\,(114.7 - 3.8) + 18\left[\frac{3.8}{114.7}\right]} = 55.2$$

Hence the weight of dry air discharged per second is

$$W = 0.00181 \times 0.74 \times 4 \times 110.9\sqrt{\frac{10 \times 55.2}{114.7 \times 620}} = 0.0529\ lb.$$

If *W* had been computed from the formula ordinarily used (which neglects the moisture constant), we would then have had

$$W = 0.0135\,C\,d^2\sqrt{\frac{h\,P_m}{T}} =$$

$$0.0135 \times 0.74 \times 4\sqrt{\frac{10 \times 114.7}{620}} = 0.0543\ lb.$$

as the rate of discharge. The difference, 0.0543 — 0.0529 = 0.0014 lb. per second, or 0.084 lb. per min., indicates the error (2.75 per cent.), which results when moist air is the gas being measured. It seems self-evident, then, that the relative humidity must play an imporant rôle in the measurement of commercial gases, whether air or otherwise.

De Waters Safety Latch

As a matter of safety to the fire-room force, every boiler furnace should be fitted with some type of safety firing door so that in case of a bursting tube the live coal, steam and water cannot be blown out of the furnace upon the men who are operating the boilers.

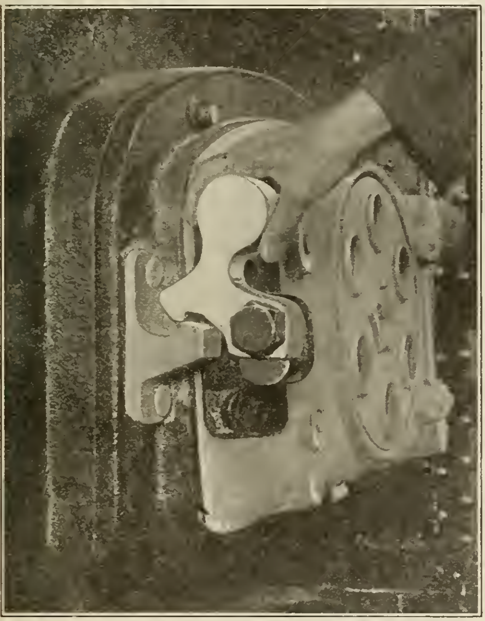


FIG. 1. DE WATERS LATCH APPLIED TO A FURNACE DOOR

Several designs of furnace doors have been used. A device that has recently been developed for safeguarding the firemen is known as the De Waters safety latch, shown in Fig. 1. It consists of an L-shaped member *D* (Fig. 2) pivoted at one end at *E*, a weight *W* on the upper end of the vertical length of the L and a latch base *B*. The movement of the latch is controlled by two bevel stop faces—*F*, which restricts the movement in the open position to the amount required to clear the latch keeper, and *G*, which limits the closing movement and brings the latch nose to a vertical contact with the keeper which holds the door securely locked until it is opened by pulling back on the weight *W*. This device is manufactured by the De Waters Safety Latch Co., Central Avenue, Far Rockaway, N. Y., and can be applied to any ordinary furnace door.

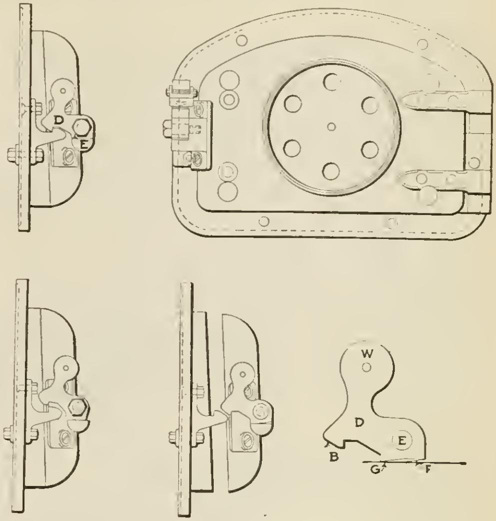


FIG. 2. DETAILS OF THE SAFETY LATCH

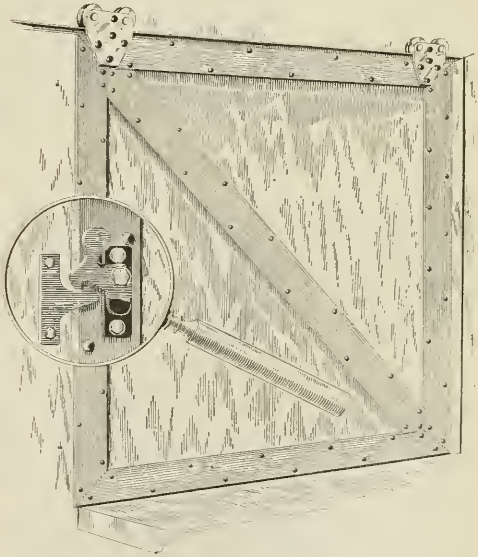


FIG. 3. APPLICATION TO A FREIGHT ELEVATOR DOOR

Two New Vilter High-Speed Ammonia Compressors

DEMAND for a small high-speed compressor that will operate noiselessly at high efficiency and require a minimum of attention led the Vilter Manufacturing Co., of Milwaukee, to develop the compact single-acting inclosed machine shown in Fig. 1. Capacities range from ½ to 18 tons refrigeration, cylinder sizes from 2.5x2.5 in. to 7.5x7.5 in. and the speeds for the different sizes range all the way from 149 to 515 r.p.m. As small motors are not built for speeds much less than 500 r.p.m., the compressor is belt, chain or gear driven.

For these speeds plate valves are employed. The suction valve is of the same type used in the larger machines. It is made of one or more thin steel rings hardened and ground to the surface. The rings are held in place by helical springs, and both are secured between two cages fitting closely together and occupying little space. The suction valve is in the piston. Ammonia vapor is drawn into the cylinder during the downstroke. The change in direction of piston movement, augmented by the action of the springs, closes the valve for the upstroke.

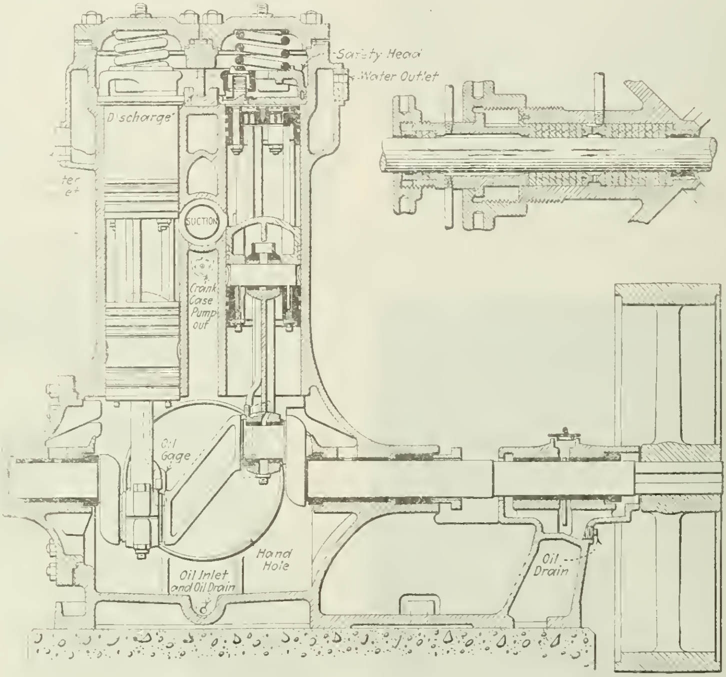


FIG. 1. SECTION OF VILTER INCLOSED-TYPE TWIN VERTICAL AMMONIA COMPRESSOR

The discharge valve is in the compressor head. It is of a modified plate type, Fig. 2, with a cylindrical recess making a tight running fit with a cylinder projecting from the safety head of the compressor. Light helical springs hold the valves in place, and a heavy spiral spring secures the safety head, permitting small striking clearance. Depending upon the area required, the discharge valve may be single or in multiple.

One of the troubles to which high-speed machines of this type are subject is oil getting past the piston and draining the crankpit, especially as they are supposed to have only occasional supervision. To guard against this difficulty in the present design a double trunk piston, with piston rings to stop both ammonia and oil, has been employed. Sufficient space has been allowed between the two parts of the piston for clearance opposite the suction-gas inlet, and as evident in Fig. 1, there is plenty of room for the required number of snap rings to prevent leakage of ammonia and on the lower part of the piston sufficient space for special oil rings and oil grooves.

Owing to its speed the compressor has large capacity for its size and the floor space occupied. Its operation is practically noiseless, and in service it is reported to have given excellent results.

In the accompanying illustrations are shown the details of the horizontal, double-acting, high-speed ammonia compressor recently perfected by the company. It is built in capacities ranging from 30 to 411 tons with maximum speeds of 164 r.p.m. for the largest size, having cylinder dimensions of 19x19 in., to 327 r.p.m. for a 9x9-in. compressor. To withstand the service, the rolling-mill frame with slight modification is used exclusively for all sizes of compressors. It is cast separate from the cylinder, and a feature out of the ordinary is the method of fastening the cylinder to the frame. Two separate sets of studs are employed, one for the frame and the other for the crank-end cylinder head. With this construction any distortion that might occur in the frame under severe operating conditions is not communicated to the head. With its own tongue-and-groove joint and its own studs, the head is independent of the frame, so that it is a simple matter to maintain a tight joint. The cylinder connection to the foot allows freedom of movement to take care of expansion or contraction. The heads are the only parts of the cylinder that are water-jacketed.

As shown in Fig. 3, the valve chambers, of which there are eight at each end, four for the suction valves and four for the discharge valves, are arranged around the barrel near the end of the cylinder and are an integral part of the cylinder. The four upper chambers are connected to the suction and the four lower ones to the discharge header. The valves, Fig. 4, are all identical in construction, but of different sizes. Each of these special plate valves is made up of one or more thin steel rings hardened and ground down to surface. The rings are held in place by light helical springs, and all is secured within two cages fastened together with a machine screw. The valve cage is held in position in the chamber by a steel stud having threaded connection to the cover plate and made tight by a special nut on the outside. The machine screws referred to simply hold the two parts of the valve together, and the springs and plates in place while assembling and handling. After the valve is in position and the studs screwed down, pressing the cage on the shoulder, which is a ground joint, no strain can be exerted on the machine screws.

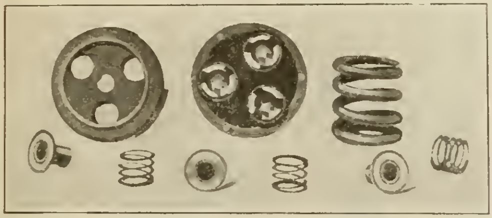


FIG. 2. MODIFIED PLATE VALVE

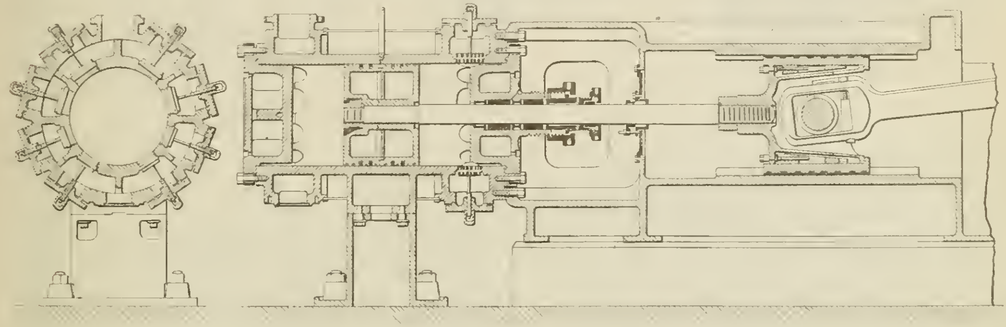


FIG. 3. SECTIONAL VIEW OF VILTER HORIZONTAL HIGH-SPEED AMMONIA COMPRESSOR

The transverse section of the compressor is shown in Fig. 3. It will be understood that the rings or plate-type valve automatically cover or uncover the ports, depending upon the pressure or suction within the cylinder acting against the spring holding the valve. The action is noiseless, and with practically no inertia, due to the lightness of the plate, the design is conducive to high speed. With the large valve area allowed by the construction, gas velocities are maintained within moderate limits. Excessive piston speed is prevented by shortening the stroke of the compressor piston. In the past it has been quite generally claimed that clearance tended to increase the required horsepower per ton of refrigeration of a compressor, but the basis for this contention has never been set forth in a clear manner. It was never shown that theory could be used in any way so as to uphold the assertion. On the other hand, the formula used in thermodynamics to express the mean effective pressure of a compressor diagram depends only upon the suction pressure and the relation it bears to the discharge pressure. Tests made to show the effect of clearance might be misleading, as changes in so many different conditions have marked effect upon the results. In this connection might be mentioned, as affecting the results, the temperature of the liquid ammonia entering the refrigerator, the temperature of gas entering the compressor, if superheated, saturated or wet, change in cylinder heating effect, etc.

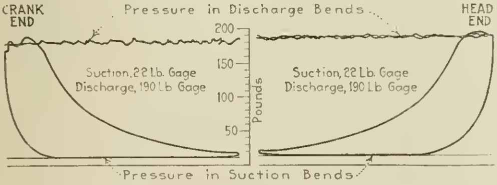


FIG. 4. INDICATOR DIAGRAMS FROM THE COMPRESSOR

With the introduction of the high-speed compressor it was necessary to make some changes in the valves, which introduced a moderate amount of clearance, as shown by the indicator diagrams in Fig. 4. The clearance is of positive benefit for the direct-connected high-speed compressor, as the compression and reëxpansion of the gas in the clearance space tends to cushion the change in movement of the reciprocating parts. The diagrams shown were taken in the usual manner and

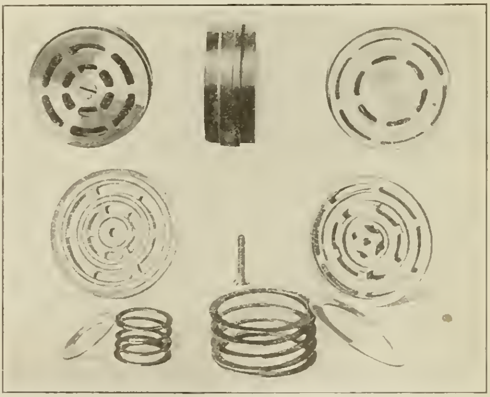


FIG. 5. PLATE VALVE FOR SUCTION AND DISCHARGE

then the indicator was opened to connections from the discharge and suction bends and lines were drawn on the cards showing these pressures as recorded by the indicator. This clearly brings out the fact that the cylinder not only completely fills with gas at the suction line pressure, but, probably due to the inertia of the gas following the piston suction stroke, fills with gas at a pressure higher than the suction line. The discharge-line pressure is only slightly above the discharge line of the diagram.

These conditions are superior to those produced by the old-type heavy poppet valve having coil springs, with some of which the pressure could not be regulated, and with others the pressure regulation was within the power of the operating engineer. It has been found by experience that many of these springs were badly regulated, requiring considerably higher pressures in the cylinder to open the discharge valves and often much lower pressures to open the suction valve. With the improved light plate valve these unfavorable conditions cannot exist. Sections of the suction and discharge valves are shown in Fig. 6.

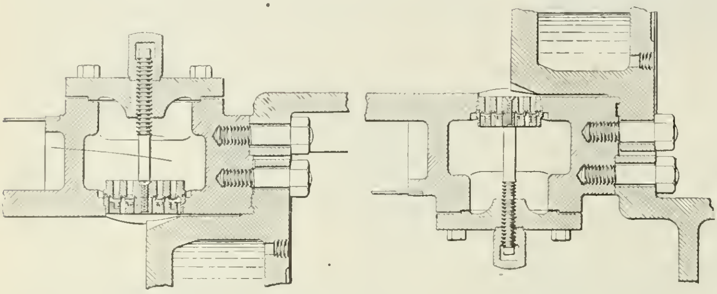

SUCTION DISCHARGE

FIG. 6. SECTIONS OF THE SUCTION AND DISCHARGE VALVES

Use and Abuse of Fuel Oil in Power Plants

By W. J. Smith

With the return of more or less normal conditions throughout the country, oil will be used to a greater or lesser extent in power plants, but the lessons learned in the use of fuel and the generation of steam will require greater vigilance and care than was used before the campaign of economy and efficiency.

During the last few years a series of tests taken at random demonstrates that a condition very far from ideal exists in most of the plants using fuel oil, very little of which is excusable, because of the ease and facility with which very nearly perfect conditions may be obtained with liquid fuel. The relation of air supply and the atomized fuel is so easily balanced and maintained that the wasteful conditions existing would not be tolerated were those in charge cognizant of the true facts.

Why the average engineer or, for that matter, his assistant should shy at the use of apparatus that requires only a very rudimentary knowledge of chemistry is difficult to understand, in view of the fact that the same men are capable of close mechanical adjustments of complicated machinery and often understand difficult mathematical formulas. Yet there are probably more plants operating at 75 per cent. or less of the possible efficiency than there are doing better than this figure.

That the average CO_2 content of the flue gas from most of the tests mentioned does not exceed 7 or 8 per cent. under ordinary operating conditions was found. When any effort was made to build up to a higher degree of efficiency, an attitude more or less of sarcasm was met, which was rather difficult to overcome. When such a simple matter as adjustment of the damper or arrangement of the air supply entering in the hearth or furnace was involved, objections of all kinds were often raised and every effort apparently made to discredit the information gained from the gas analysis, even when diplomacy was used in making such suggestions. It is a well-demonstrated fact that any plant burning fuel oil in quantity which operates at an average of less than 13 per cent. CO content in its flue gas is operating under adverse conditions, and no engineer who thoroughly appreciates the possibilities would be satisfied with anything markedly less.

I have in mind a number of plants in which some slight adjustments or stoppage of air leakage about the settings has effected marked results and economies. For instance, one of the large steam-power plants operating in British Columbia, consuming under a full load nearly five hundred barrels of oil per day, by a change in the draft reduced this consumption by nearly fifty barrels, surely something worth going after! To go to the other extreme, a small plant with one horizontal-tubular boiler, by raising the CO_2 content from 6½ to 12 per cent. saved about three barrels per day. Many operators or firemen are in the habit of running with a large excess of air, producing a very short white flame, and together with an excess of steam for atomizing, produce conditions that lead to high velocity of the gas travel through the boiler passages and consequently high terminal stack temperature.

Instances have been frequently met where no provision existed for any close regulation of stack draft. It is necessary that there be means to regulate the damper very closely in order to produce the best furnace conditions. It is frequently necessary to make such adjustments of damper and atomizing agency that the fire has a much different appearance from that the firemen and operators have been accustomed to. However, it may safely be said that with the air supply closely balanced to the requirements and other adustments properly made, the reduction of fuel consumed will be gratifying to owner and conscientious employee alike.

A good rough and ready rule in the absence of an apparatus for determining furnace conditions is, after the fires are well alight and the furnace hot, to reduce the air supply by means of the stack damper to a point where the flame has a slight smoky appearance, then open just sufficiently to clear it. Lacking a CO_2 recorder, the use of the Orsat will enlighten the operator as to what conditions are best, and it is safe to say that he will not depart very far from them once that point is reached.

Power-Factor Adjustments by the Use of Synchronous Motors

By ROBIN BEACH

Associate Professor, Department of Electrical Engineering, The Polytechnic Institute, Brooklyn, N. Y.

Presents in a nontechnical manner the effects of low power factor, the leading power-factor characteristics of synchronous motors, the application of synchronous motors to power-factor adjustment and the extent and effects of their corrective influence.

BECAUSE of the vast number of induction machines such as transformers, induction motors, arc lamps and various types of small devices, alternating-current circuits generally operate with lagging power factors varying over wide limits. Each individual machine or piece of apparatus has its own power-factor characteristic for its load range. Some types of machinery have rising power factor for increasing loads, others have a practically constant range, while still others have decreasing values of power factor for increasing load. It is the aggregate effect of these which determines the power factor at the distributing center. Since induction motors constitute the major portion of load equipment and their power factor increases as the load increases, the power factor in the system will be affected by the degree of loading of the apparatus. If it is all operating at full load or overload, the power factor of the system will be at its highest. If the equipment is only slightly loaded, the resultant power factor will be low. Intermediate degrees of loading will give a power factor lying between these limits.

TABLE I. HEAT LOSSES CAUSED AT DIFFERENT VALUES OF POWER FACTOR

Kw. Load on Machine	Power Factor, Per Cent.	Voltage at Machine	Current in Amperes	Heat Losses in Line
1000	100	1000	1000	1 00
1000	80	1000	1250	1.56
1000	60	1000	1667	2 77
1000	50	1000	2000	4.00

The foregoing emphasizes the important facts that motors which run at underrated load not only mean low efficiency at additional expense to the customer, but also low power factor, which decreases the efficiency of the generating and distributing equipment. Consequently, advice with the central-station management regarding the choice of proper capacity equipment before purchase would lead to a mutually beneficial and satisfactory purchase, since machinery would be recommended the capacity of which would represent, generally speaking, the average load. Attention on the part of salesmen and electricians to giving machinery the advantage of its overload capacity rather than the too common present practice of working considerably under the rated capacity would tend toward better service throughout.

In a circuit having a low power factor it is necessary to draw a relatively large current for a given load in kilowatts with a corresponding line voltage drop. Consequently, for a given kilowatt load the line impedance drop is large for low power factor and small for high power factor. This means that the voltage regulation will vary between wide limits, which is unsatisfactory for the proper functioning of certain types of machines. The pulling power of induction motors varies as the square of the voltage, consequently if the voltage is reduced a certain percentage of normal, the torque is reduced to the square of the lower voltage.

Table I shows the relative increase in heat loss in the transmission of a given amount of energy at various power factors. The heat loss at unity power factor is taken as unity. It will be observed that the current increases rapidly for decreasing power factor. The voltage, which is assumed constant at 1000 volts, because of poor regulation would actually be not constant but decreasingly smaller, and for the given power would necessitate still larger currents than those shown. The effect of low power factor is obviously bad, and measures taken to improve it are not only favored but demanded by present practice. Central plants are in some cases imposing penalties upon customers operating loads with a power factor lower than a specified value.

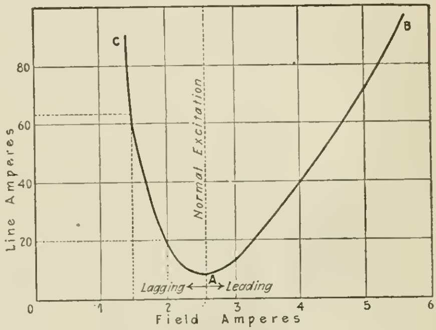


FIG. 1. SYNCHRONOUS-MOTOR EXCITATION CURVE

TABLE II. CURRENT AND POWER-FACTOR VALUES FOR THE CIRCUIT IN FIG. 2

Load Units Connected to Supply as Indicated Below	Current and Its Power Factor for Given Sections of Line									
	Section A to B		Section B to C		Section C to D		Section D to E		Section E to F	
	Current in Amp.	Per Cent. Power Factor	Current in Amp.	Per Cent. Power Factor	Current in Amp.	Per Cent. Power Factor	Current in Amp.	Per Cent. Power Factor	Current in Amp.	Per Cent. Power Factor
B only	100.0	80.0	.....	....	.....	.....	....	....	......	.....
B and *C* only	298.4	70.5	200.0	65.0	.....	.....	....	....	......	.....
B, C and *D* only	394.0	76.2	294.3	74.7	100.0	90.0	....	....	......	.....
B, C, D and *E* only	688.3	64.3	590.7	67.6	391.5	69.1	300	60	.....	.....
B, C, D, E and *F*	1017.8	96.5	954.9	98.3	810.0	99.97	*—720.2	*—99.96	*—600	*—90

* Leading currents and power factors are indicated by minus sign.

Whereas, induction machinery inherently causes a lagging of the current behind the circuit voltage, not all electrical equipment falls in this group. Some types of apparatus have practically no inductive effect upon its circuit, and the current that it takes is in phase with the voltage. This class of apparatus is called noninductive. The third class of equipment using electrical energy takes a current from the main line which leads the voltage. Such is the distinguishing characteristic of a condenser. A long transmission line acts as a condenser in that it sometimes requires hundreds of amperes of charging current, leading the impressed voltage by an angle of nearly 90 degrees.

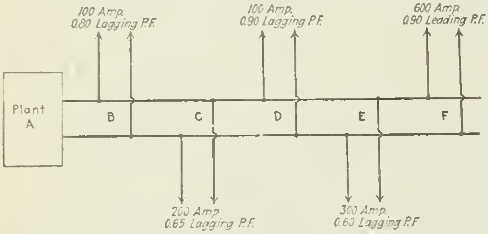


FIG. 2. LOAD DISTRIBUTION ON A CIRCUIT

The current taken by a synchronous motor or a rotary converter may be made to lead the voltage by any desired amount. This condenser characteristic in causing a leading current to flow is now applied successfully in practice to correct for the large lagging currents caused by induction equipment. By applying a leading current of proper magnitude and phase, relative to the lagging current, the resultant current may be made to be in phase with the voltage so that the system operates at unity power factor. To illustrate this by example, consider a group of induction machinery taking 100 amperes, which lags the impressed voltage by 60 deg., which is equivalent to a power factor of 0.50. The condenser equipment must take a current of 100 amperes at a 60-deg. angle of lead in order to adjust for unit power factor in the system. The resultant current will be 100 amperes in phase with the voltage. The power delivered is 100 per cent. greater than before, for the same power lost in heating the transmission line and the voltage regulation for constant voltage impressed upon the line at the generator has been improved from 26.1 per cent. to 9.87 per cent.

Synchronous motors of very large capacity have been installed for no other purpose than to create this condenser characteristic and to correct for lagging power factor. When so operated without load, it is called a synchronous condenser. Machines of capacity ranging from 2000 to 3000 kv.-a. are commonly found in operation in the large systems where energy is transmitted over long distances, and machines as large as 15,000 kv.-a. have been installed. These units are capable of large capacity ratings at approximately zero power factor leading or lagging. Sometimes a lagging power-factor current component is required from the synchronous condenser in order to neutralize the effect of the leading-current characteristic of the charging current in a long, lightly loaded high-voltage transmission line

For every synchronous motor there is a certain value of field current for each load that will cause its load current to be in phase with the voltage. If the field current is increased above this value, the load current becomes leading in respect to the line voltage, and a decreased field strength causes a lagging current to flow. The least current taken from the line to operate the motor is at unity power factor, and this excitation is called "normal field current." When the excitation is decreased, the line current required to operate the motor not only becomes lagging, but, in order to supply the same kilowatt load, must be much greater in value. This is illustrated graphically in Fig. 1, where the normal excitation is indicated as 2.5 amperes. When the excitation is reduced to 2.0 amperes, the line current becomes 20 amperes and for 1.50 field amperes, the line current is 64 amperes. Also increased field current above normal gives rise to line current of rapidly increasing value with leading power factor, as shown by the curve *AB*. Therefore, it is evident that the magnitude and phase characteristic of the current of a synchronous motor may be varied at the will of the operator by changing the field current above or below normal.

The limitation to the amount of current that the synchronous motor may take from the line is imposed by the maximum safe heating allowable as in any electrical machine. Therefore, the use of the synchronous motor as a device to supply a leading current to neutralize the lagging current taken by induction machinery becomes evident at once.

Fig. 2 shows a plant *A* supplying loads placed at *B*, *C*, *D*, *E* and *F*. Table II, which is self-explanatory, gives the current in each part of the circuit and its power factor. The leading current taken by the synchronous motor placed at *F* is seen to have a most beneficial effect upon the system by raising the power factor and rendering a more economical transmission of energy, superior voltage regulation with resulting satisfaction for operating conditions.

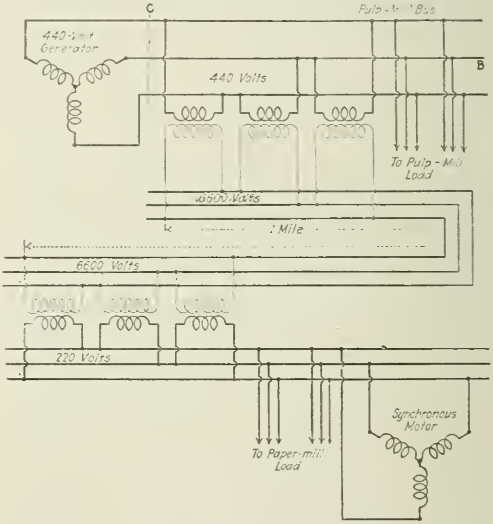


FIG. 3. PAPER- AND PULP-MILL LOAD DISTRIBUTION

A synchronous motor located near the end of a transmission line may, by virtue of its leading current characteristic, raise the power factor at the distribution center of load from its previous low value, say 65 per cent. lagging, up to a value as high as 95 per cent. lagging or unity power factor, depending upon the kilovolt-ampere capacity of the motor relative to the amount of lagging component of the load.

Since the least amount of current is required for a given kilowatt load at unity power factor, the indications on the main ammeter are indicative of the approximate position of unity power factor. By varying the motor excitation continuously in one direction (say increasing the excitation), if the main-line ammeter's indication steadily decreases to a minimum value and then begins to increase again, the power factor has been rising to unity after which the corrective leading current predominates in the system and the power factor becomes leading. The best method for power-factor indication is, of course, by the use of a power-factor meter. This instrument should be an indispensable adjunct to the system at any point of particular interest in regard to power factor.

Consider the problem involved in the following typical small system, Fig. 3. The synchronous motor is located at the end of the transmission line, in the paper mill, and may be used to raise the power factor of the paper-mill distributing system. The transmission losses will have been considerably reduced by this method, the generating system relieved of a large heating component and the voltage regulation at the paper mill materially benefited. The pulp-mill bus will have a power factor determined by the aggregate of all the machines operating therefrom. The power factor at the generating station will of course be lagging, since the combined lagging power factor of the pulp mill and the power factor of the paper mill, even though the latter be unity, must be less than 100 per cent.

Suppose that a synchronous motor were located at *B* instead of in the paper mill. The pulp-mill bus could have its power factor adjusted to unity. The paper mill would have a lagging power factor determined by the combined effect of its machinery. At the generating station the paper-mill current would combine with that of the pulp mill, the latter assumed to have unity power factor, and the resultant current from the generators would still be lagging, but with a value less than that of the paper-mill line. This position of the synchronous motor would be inferior to the first arrangement, since the line loss in transmission would not be reduced and the line regulation would not be benefited.

A synchronous motor located only at *C* could be so adjusted provided its capacity were sufficiently large that it would correct for the combined lagging current from both the paper mill and pulp mill. This would mean that the current flowing from *C* to the pulp mill would lag by an angle determined by its machinery and that flowing to the paper mill would lag by an angle determined by its machinery. However, the current at the generator would be in phase with the voltage. The generator would be working at high efficiency and good regulation, yet the same objection is present as in the case where the synchronous condenser was located at *B*. It does not aid in the efficient transmission of the energy.

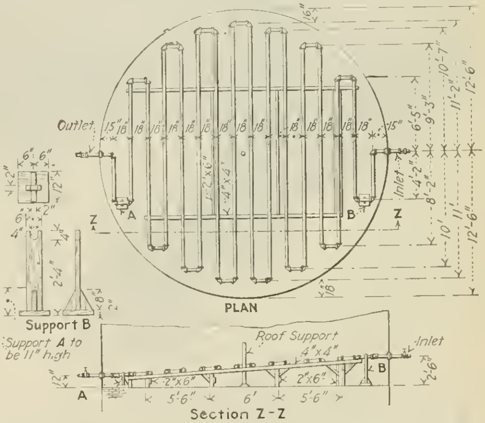
The ideal arrangement in this problem would be to have a synchronous motor located at each mill as in the position. These would correct the power factor of their respective lines and then the power factor at the generating plant would be practically 100 per cent., and the system would then be operating at its highest efficiency and with the best regulation for the given conditions.

Synchronous motors are being applied in practice not only for power-factor correction, but also for voltage regulation on long transmission lines. Either the natural line reactance or artificial reactors are located in the system, and by virtue of the leading or lagging current caused by the synchronous condenser the reactance voltage drop will either add to or subtract from the line voltage. The resultant voltage, therefore, may be kept within reasonably narrow limits by the inherent characteristic of the synchronous motor when floated on the line to maintain a constant voltage across its terminals and acts as a balancing medium to establish equilibrium of the phases in regard to both current and voltage in cases of unequal loading. It will take energy from the high-voltage phase or phases and supply energy to the lower-voltage phase, thereby automatically regulating for uniform voltage drop. Some notable installations are in operation where under the most severe load conditions the voltage regulation is maintained by this method within 2 per cent. plus or minus of the required voltage.

The application of synchronous condenser machinery has had such success in all of its installations that it has become a necessity in alternating-current plants where good regulation, reliability of service and general satisfaction are of primary importance. The results accomplished by way of regulation and power-factor adjustment, with synchronous motors are most interesting, and further developments are expanding the possibilities of their application.

Fuel-Oil Tank Heating Coil

The illustration shows the assembly and details of a heating coil for an upright steel fuel-oil tank as used by the Standard Oil Co. The drawing will doubtless interest many who are now confronted with fuel-oil storage problems.



HEATING COIL AS USED IN UPRIGHT STEEL FUEL-OIL TANKS BY THE STANDARD OIL CO.

Where breaking of a piston ring caused a piece thereof to become lodged under a valve, resulting in the piston making a violent movement and causing injury to an employee, the employer is liable if it can be shown that the piston ring was badly worn before the accident and that the foreman in charge knew of that fact long enough to have permitted repair of the defect before the accident occurred. (Springfield, Mo., Court of Appeals, Yarborough vs. Wisconsin Lumber Co., 211 Southwestern Reporter, 713.)

PERMANENCY OF REFRIGERATION INSULATION

By John E. Starr*

Columns of discussion and voluminous trade literature have been devoted to the properties of various insulating materials, based entirely upon heat conductivity. Few insulating materials available differ more than 10 to 20 per cent. in this respect. The crux of the subject is obscured by the usual argument to the neglect of more important considerations urged in this article.

Refrigeration is the process of taking away heat from a substance or an area which we desire to keep cool and putting the heat somewhere else. To reduce the amount of refrigeration or cost of taking away of heat, it is as a rule an advantage to surround that substance or area with a wall that has the property of retarding the passage of heat from the warm outside to the cool inside, so as to reduce the amount of heat to be taken away. As no substance or material entirely stops the flow of heat from a warm body to a cool one, the total line of calculation lies in balancing the cost to take away heat against the cost to retard the flow of heat. But the initial figures are not all there is to it.

The main question, after all, is, How long will the original figures, based solely on the passage of heat, hold good? Or, in other words, What is the *permanency* of the insulating structure and how long will it continue to retard the passage of heat at only the same rate as when first installed? As a commercial proposition it is in the first place not always the best resistant to the passage of heat that pays the best.

The figures that show, for example, the least passage of heat or the least number of B.t.u. per square foot per day per degree difference of temperature are misleading when taken alone. Without considering permanency, let us contrast two cases one in which an insulation, say, of some insulating board 4 in. thick showing by test a passage of 6.5 B.t.u. per day per square inch per degree of temperature difference, costing erected and faced 70c per sq. ft., 4 in. thick, and another showing 7.5 B.t.u. costing 60c. and assume that refrigeration costs for fuel 35c. per ton and in both cases 100,000 sq. ft. are involved, and that the average difference of temperature for the whole year is 50 deg., interest 6 per cent. (See Tables I and II.)

From this example it would appear that the insulation that passed more heat, or what usually is considered the poorest insulation, would be the better to buy as far as heat alone was concerned. But after all the main question is left unsettled by the figures given, and, of course, these figures are merely illustrative and might be modified by circumstances. The main question is: How long would the insulation continue to show these relative rates of the transmission of heat? If No. 2 transmits more heat per square foot as time passes, the original figures would manifestly be impaired.

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*Consulting Engineer, New York City.

It needs little calculation to show that by the time No. 1 insulator depreciated only 5 per cent. as to heat conductivity and No. 2 depreciated 10 per cent, the figures would be reversed. So the most important item is that of depreciation, assuming that the insulating figures differ 15 per cent. or even 20 per cent.

Moisture the Principal Cause of Depreciation

Concentrating on the question of upkeep or durability, it may be said that the invasion of moisture—ever present in the atmosphere—is the principal cause of depreciation. Water is a better conductor of heat than most materials used in insulation; therefore, as the insulation becomes moist, its heat-conducting properties are increased.

Actual experiments on a 10-in. thickness have shown an increase of 25 per cent. from dry to slightly moist and 67 per cent. from dry to 30 per cent. moist. But the effect of moisture is also inimical to the insulation in addition to increasing its conductive property, especially in freezers.

TABLE I. COST OF INSTALLATION NO. 1, OR COST OF INSULATION

$$0.70 \times 100{,}000 = \$70{,}000$$

$$\frac{6.5}{4} \times 100{,}000 = 162{,}500 \text{ B.t.u. per deg.}$$

$$162{,}500 \times 50 \text{ deg. difference} = 8{,}125{,}000 \text{ B.t.u. per day}$$

$$\frac{8{,}125{,}000}{288{,}000} = 28 \text{ tons refrigeration per day}$$

$$28 \times 365 \text{ days} = 10{,}220 \text{ tons per year}$$

10,220 tons at 35c cost per year to take up heat	$3,577.00
Interest on $70,000 at 6 per cent	4,200.00
Total cost, exclusive of upkeep per year	$7,777.00

TABLE II. COST OF NO. 2 INSTALLATION, OR POORER INSULATION

$$0.60 \times 100{,}000 = \$60{,}000$$

$$\frac{7.5}{4} \times 100{,}000 = 187{,}500 \text{ B.t.u. per deg.}$$

$$187{,}500 \times 50 \text{ deg. difference} = 9{,}375{,}000 \text{ B.t.u. per day}$$

$$\frac{9{,}375{,}000}{288{,}000} = 32.5 \text{ tons refrigeration per day}$$

32.5 tons at 35c for 365 days	$4,151.87
Interest on $60,000 at 6 per cent	3,600.00
Total cost, exclusive of upkeep per year of poorest insulation	$7,751.87

Moisture, when it has once penetrated the insulation having a freezing side, is likely to stay there in large part and to freeze. The expansion of freezing to ice causes the water between the fibers or granules to expand and tear the latter apart and breaks the bond between them. Thus the structure of the material is broken down with the alternate freezing and thawing.

Many have observed this in the case of cork having one side exposed to atmospheric moisture and the other side below 32 deg. F. The granules become separated, and what was once a solid board becomes a mushy mass of wet granulated cork, to be removed best by a shovel, and of little value as an insulator. The same with fibers.

Testing by Soaking Not Conclusive

Testing the insulation by soaking for a day or two under water is not conclusive, for a structure so tested and showing light absorption will, after drying out, show on a weighing scale increase and decrease of weight when exposed to the ordinary atmosphere. Such increase and decrease following the curve of relative humidity of the air.

As much as 5 oz. of water to 1 sq. ft. of 2-in. thick insulation has been observed as an increase of water content in an insulating board during a change from 60 per cent. to 90 per cent. of relative humidity, this minimum to maximum change occurring in three days. Almost any piece of insulating board placed on a fine weighing scale becomes a good hygroscope, and relative humidity can be deduced from it with accuracy after the relation of its weight to humidity is once established and this at near the same temperatures.

How much more this effect of accretion of moisture may be when one side is cold and the other side warm can hardly be determined by experiment, as the protection offered by practical building walls can only be estimated.

It is submitted, however, that this test of hygroscopic effect is as valuable as a conduction test as an indication of the net value of an insulation against heat.

Moreover, a cold-storage warehouse breathes. That is to say, the pressures on the inside are above and below the pressures on the outside in a closed house, according to the changes in outside atmospheric pressure and inside changes of pressure due to opening of doors alternately collapsing and equalizing with the outside pressure. In warehouses using forced air distribution, the effect is noticeable. Three-tenths of an inch of water less pressure inside than outside in parts of the warehouse have been observed. Practical considerations would therefore argue for an equalizer of pressure, say in the shape of a small pipe from the closed inside room to the outside temperature.

Beneficial Effect of Pressure Equalizing Pipe

The loss of refrigeration by such an opening would be negligible, but the prevention of a pressure head against the entire surface and consequent forcing of moisture inward when the room "breathed in" would be eliminated. Also, any waterproofing of the outside wall or outside insulation is of value, as the moisture comes from the outside.

Waterproofing the wall or laying the insulating board in a good layer of hot asphalt or both are preferable to laying up in the more permeable cement mortar. Any attempt to render the insulator itself moisture proof is best of all, as it is almost impossible practically to render the armor invulnerable at all points. This latter work should be done even at some expense of reasonable conduction, considered alone.

We can standardize insulating value as far as transmission of heat is concerned, but until we can standardize upkeep we can never more than guess at the true commercial value of a heating-insulating structure.

Chart for the Determination of Circulating-Water Flow

By Edward S. Bristol

In the operation of a surface condenser it is often desirable to check up the circulating-water flow. For instance, the vacuum may fall off and it may at once be suspected that the circulating-water pump is not maintaining its normal discharge. The process of checking up the flow by calculation is not as familiar as some other computations that are more frequently employed in the power house. If the desired result could be obtained in an easy and convenient manner, it is believed that its value in condenser operation would be more fully appreciated. It was with this end in view that the accompanying chart was constructed.

The chart is intended for use with a generator unit, and for its use it is necessary to know only quantities that are ordinarily measured and recorded as part of the daily routine. These quantities and their values as used in the illustrative problem are as follows:

Steam pressure at throttle of main unit, 212 lb. per square inch gage.

Steam temperature at throttle of main unit, 427 deg. F.

Load on generator, 12,000 kw.

Condensate per hour, 170,000 lb.

Temperature of condensate, 97 deg. F.

Circulating water temperature rise, 5 deg. F.

The method of using these quantities in the chart is indicated by the dotted line. Taking the throttle steam pressure, 212 lb. per sq.in. gage, and temperature 427 deg. F., for the main unit a start is made in the upper left-hand section of the chart by finding the total heat in the steam at the throttle, 1222 B.t.u. per lb. This point is held while the main unit water rate is found in the upper right-hand section by locating the intersection of the steam consumption (condensate per hour), 170,000 lb. per hour, with the load on the generator, 12,000 kw. The water rate need not be read off (on the scale to the right) unless its value, 14.2 lb. per kw.hr., is desired, but should be carried over horizontally to an intersection with the solitary curved line sloping to the right. The point thus determined is carried down parallel to the lines labeled "water rate" until the previously found total heat in the steam is reached. From this point pass vertically downward to the temperature of the condensate, 97 deg. F., as given by the sloping lines in the lower right-hand section. From here proceed horizontally to the left to the circulating-water temperature rise, 5 deg. F., as given by the parallel lines sloping to the right. This point locates the number of pounds of circulating water per pound of condensate, 180, as given by the scale at the bottom. Proceed vertically from the last point to the pounds of condensate per hour, 170,000, as given by the lines radiating from the upper left-hand corner. This intersection locates the desired circulating-water flow, 61,400 gal. per min., as given by the scale on the left.

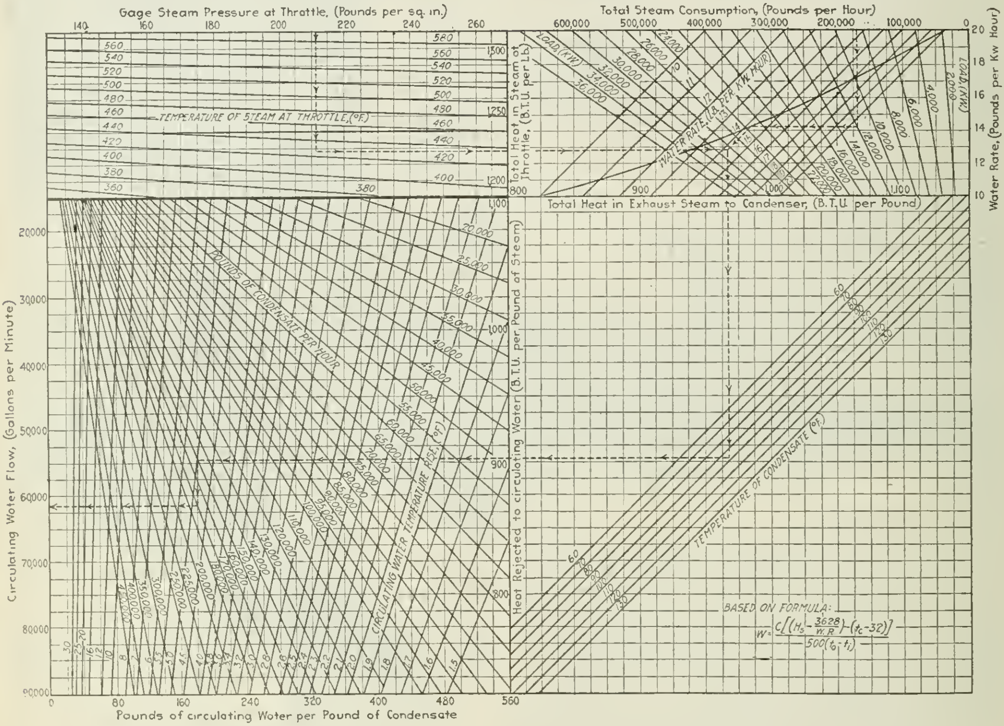


CHART FOR THE DETERMINATION OF CIRCULATING WATER FLOW

The chart is based on the equation,

$$W = \frac{C\left[H_s - \frac{3628}{W.R.}\right] - (t_c - 32)}{500\,(t_o - t_i)}$$

where

W = Circulating-water flow in gallons per minute;

C = Pounds of condensate per hour;

H_s = Total heat in the steam at the throttle, B. t. u. per pound.

$W.R.$ = Water rate, pounds per kilowatt-hour;

t_c = Condensate temperature, degrees F.;

t_o = Circulating water outlet temperature, degrees F.;

t_i = Circulating water inlet temperature, degrees F.

The figure 3628 is the heat equivalent of 1 kw.-hr. (3412 B.t.u.) divided by 0.94 to allow for a 6 per cent. friction and radiation loss in the generator. To reduce the circulating-water flow from pounds per hour to gallons per minute the figure 500 is introduced.

McDonough Single-Tube Feed Water Regulator

A thermostatically controlled feed-water regulator has been perfected by the McDonough Automatic Regulator Co., Detroit, Mich. As is shown in the illustrations, it is of simple and strong construction and positive in action, with a lever ratio designed to insure prompt operation of the feed valve. The center of the copper expansion tube is rigidly stayed to a steel framework which permits the expansion or contraction of the tube in either direction from the center through the flexible supports to which it is connected. Along the length of the tube are supports that will allow movement in a longitudinal direction, but prevent sidewise or vertical buckling.

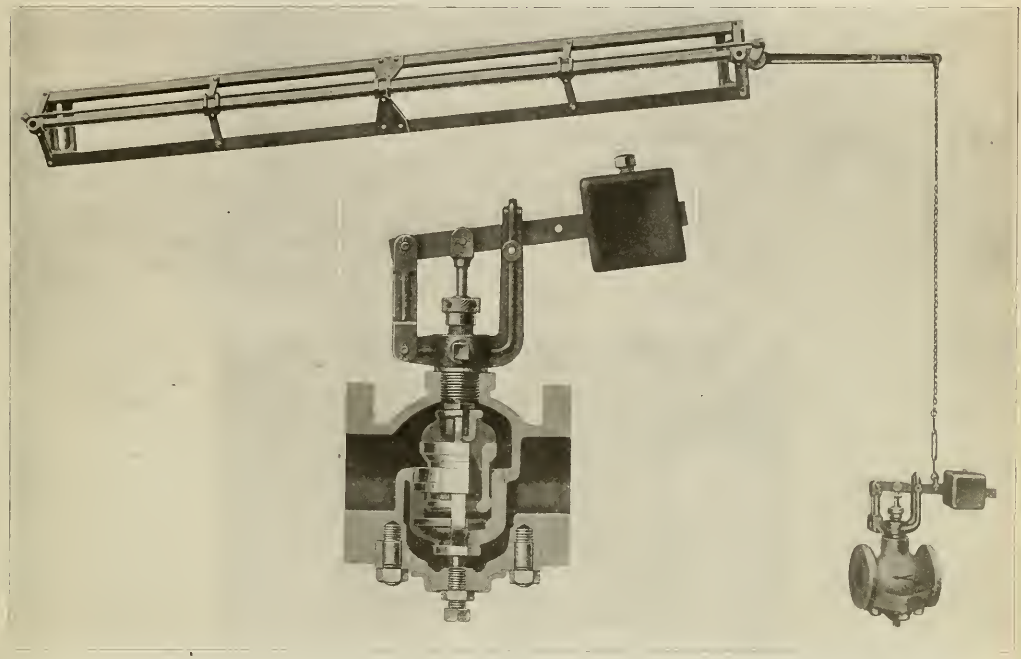
At the lower end the thermostatic tube is connected below the water level of the boiler and the upper end to the steam space, the slope of the tube determining the limits of action. Bolts in radial slots at either end of the regulator permit an additional incline or decline after the device has been installed. The operating lever can be attached to either the water or the steam end of the tube and can be adjusted to meet plant conditions.

The action of the tube operating the lever depends upon the changing water level in the boiler and the amount of steam or water entering the expansion tube.

The convenient features of the feed valve are shown in the sectional view. Whether of the beveled-seat or balanced type, it is placed within a cage and can be quickly inserted or removed by hand through a flanged opening covered by a plate bolted to the bottom of the valve body. As a consequence it is not necessary to remove the valve body from the pipe line or to disturb the bonnet or working parts for examination or regrinding of the valve parts.

The valve stem is connected to the valve-operating lever by a clamp yoke which permits the stem being disconnected for the removal of the valve and stem. A swivel connection is provided at the lower end of the stem to allow the valve to properly adjust itself to the seats in the valve cage.

Another feature is that the yoke of the valve is of swivel construction so that it can be turned around in any position and locked to the bonnet by a setscrew. This is often desirable when lining up the lever of the valve with the lever connected to the thermostatic tube.


McDONOUGH SINGLE-TUBE FEED-WATER REGULATOR AND SECTION OF FEED VALVE

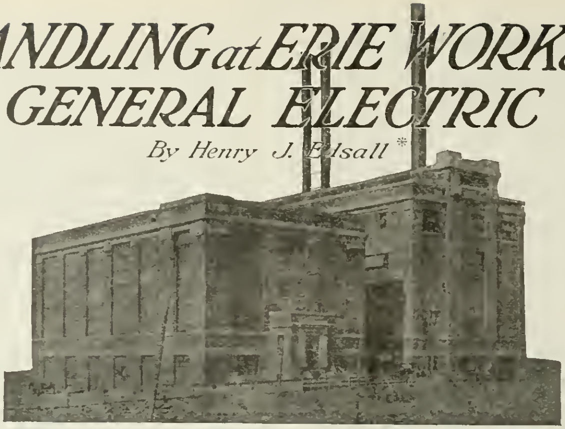
It will be noticed that the counterweight on the valve-stem lever is adjustable and is secured at the desired position by means of a setscrew. Its function is to partly or fully close the valve as the water level rises.

By means of a chain a steel pin is connected to the yoke for the turning of the packing nut or to hold the valve in an open position by the insertion of the pin in the hole in the guide arm of the yoke when refilling a cold boiler.

As the water falls or rises in the boiler, it correspondingly falls or rises in the thermostatic tube, with a corresponding increase or decrease of the length of the tube occupied by the steam, causing it to expand or contract to regulate the opening of the feed valve and admit the proper amount of water to the boiler. In this way a constant feed to the boiler in proportion to the demand is obtained and the high efficiency of a practically constant water level insured.

COAL-HANDLING at ERIE WORKS PLANT OF GENERAL ELECTRIC CO.

By Henry J. Edsall*



MODERN power plants have become more or less standardized in both building and equipment but this does not, of course, mean that they are all built alike. Conditions and requirements vary, and engineering opinions also still differ as to the most suitable types of buildings to be used for boiler and generator rooms, the location of generator room in relation to the boiler room, types and arrangement of coal- and ash-handling equipment, stokers, stacks, steam piping, flues, etc. The generator-room equipment is settled down to more definite standards than the boiler-room equipment, and the building required to house this equipment is of a comparatively simple type. The shape of the boiler-room building, however, depends largely upon the type of coal-and ash-handling equipment to be used, the arrangement of the boilers and steam piping, the location of economizers, if used, and the arrangement of the stacks and flues. There are various combinations possible, and while certain arrangements are considered more or less standard, these are not always adhered to.

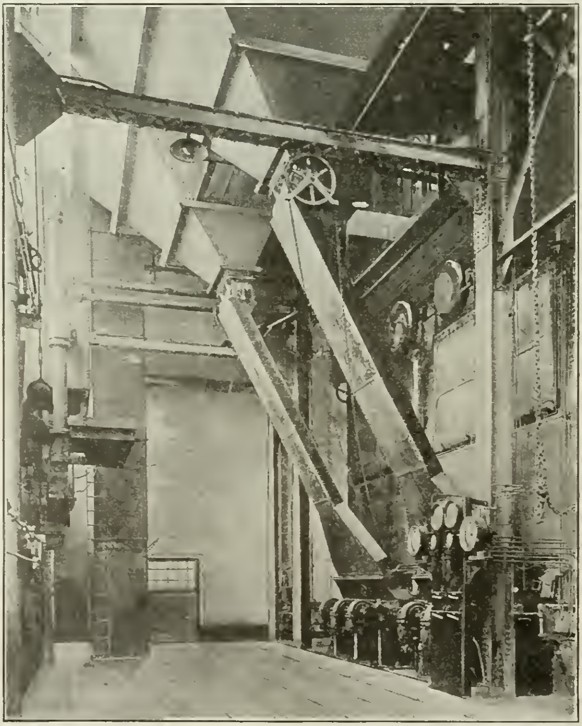


FIG. 1. PART OF OVERHEAD BIN AND SPOUTS TO STOKERS, WITH COAL ELEVATOR IN BACKGROUND

The design of the new power plant of the General Electric Co. at Erie, Penn., was developed under the direction of August H. Kruesi, engineer of the Construction Engineering Department, and it is unique in a number of features. One feature that has been given special attention is future development, and the boiler room as built at present is only one-fourth the ultimate size. The design, therefore, was arranged for the present requirements and also for flexibility and low cost of future extensions.

Ample light for the operating space in front of the boilers has been obtained by facing them toward the outside wall of the building and providing a generous supply of windows in this wall, Fig. 1. The boilers will also face toward the light in future extensions. Ventilation has been provided for by ventilators in the front windows and in the monitor overhead.

The coal-handling equipment includes overhead bin over the space in front of the boilers, with spouts direct to the stoker magazines, the overhead bin capacity being sufficient to run the plant for about two days. In addition there is a reserve coal storage which, instead of being placed outside the building, is located in the basement of the building and unloaded into a storage space underneath the tracks. This necessitates a deep basement, but makes it possible to do all the unloading under cover, therefore there are fewer chances for delays or a coal shortage, as frozen cars of coal can be run into the basement and allowed to stand long enough to thaw out before they are unloaded. This feature is a decided advantage where the winters are severe.

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*Engineer with Link-Belt Company.

For elevating the coal and distributing it in the overhead bin, standard chain and bucket elevators and rubber-belt conveyors were selected. These machines made a comparatively simple design possible for the present boiler room, and also provided for the future extensions with as little additional expense as possible. Only coal is handled by the conveyors, the ashes being dumped from the ashpits under the stokers into railroad cars standing on the tracks in the basement of the building.

The present boiler room contains six 600-hp. Babcock & Wilcox boilers, four of which are equipped with Taylor stokers and two with Riley stokers. The boilers are set in a single row in batteries of two. Each battery occupies a space of about 30 ft., with spaces between the batteries of 10 ft. center to center of columns, and similar spaces at the ends, so that the total length of the present building, center to center of the columns, is 130 ft. Space for economizers is provided over the boilers. Three railroad tracks are run into the building on a level 28 ft. below the operating flood, and underneath the railroad tracks is the reserve cold-storage space, the bottom of which is 23 ft. below the track level or 51 ft. below the operating-floor level.

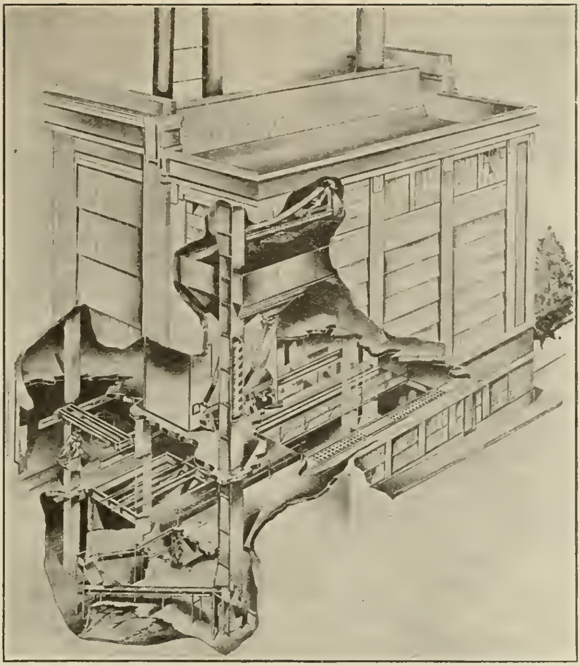


FIG. 2. GENERAL ARRANGEMENT OF BOILER ROOM

The track hopper for feeding coal to the conveyor system is located underneath the center track and the outside tracks run underneath the present and future ash hoppers. Fig. 2 shows the general arrangement of the boiler room.

The present boiler room has been built with one temporary side wall and one temporary end wall, and the first extension contemplated is to double the width of the present boiler room and put in an additional row of boilers, facing in the opposite direction, toward the future outside wall. The additional extensions will be to double the length of the boiler room, either doing one side first and then the other or both together, according to requirements. The generator room is placed alongside the boiler room and has one temporary end wall so that it can be extended to double the length in the future, this being the ultimate size of the generator room as planned.

The track hopper is underneath the center track near the temporary end of the boiler room, and when this room is extended the full length it will be near the center of the building. This track hopper is unusually large, the length being 28 ft. so as to take in all the hoppers of the largest railroad cars without moving them, and the width being over 20 ft. so as to provide for two

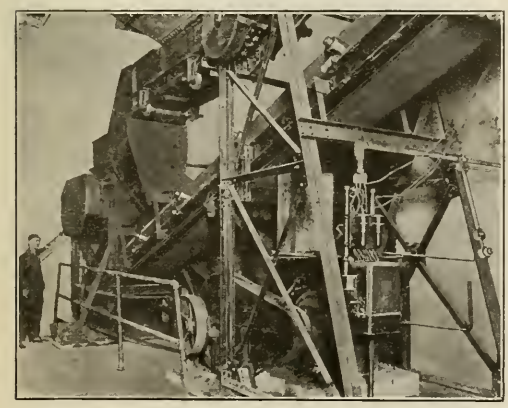


FIG. 3. FEEDER AND CRUSHER UNDERNEATH TRACK HOPPER AND BELT CONVEYOR No. 1

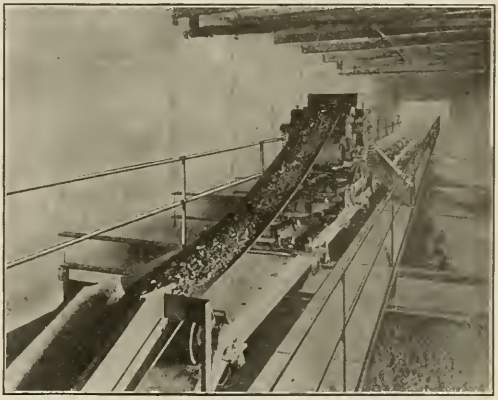


FIG. 4. DISTRIBUTING BELT CONVEYOR DELIVERING TO OVERHEAD BIN

feeders underneath. The track is supported over the hopper on 15-in. girder beams, framed into heavy girders. The hopper itself is made of ⅜-in. steel plates, stiffened by angle irons. Underneath the hopper there is a standard reciprocating feeder below one of the hopper openings, and a place for a future feeder below the other hopper opening. This feeder is 30 in. wide by 10 ft. long and feeds the run-of-mine coal automatically to a chute leading to the crusher. The bottom of the chute is fitted with a screen plate of the lip-screen type with openings 6 in. long and varying from 1 in. to 1¼ in. in width. The fine coal passes through this screen and is delivered to belt conveyor No. 1, located underneath the feeder. The large coal passes on down the chute to the crusher, Fig. 4. In case coal that has already been screened to the proper size is received, the screen plate on the bottom of the chute can be raised so as to allow all coal to pass through to belt conveyor No. 1 without any of it going to the crusher.

The crusher is a standard 30x30-in. two-roll spring relief machine, and it is supported on a steel frame about 6 ft. 4 in. high above the floor. The foot of belt conveyor No. 1 is located underneath this steel frame so that the coal that passes through the crusher can be delivered to the belt. This belt conveyor runs in the same direction as the railroad track and underneath it, but a little to one sde of the center, the distance from the center of the track to the center of the belt being about 4 ft. It is set at an incline of about 18 deg. The belt is a 24-in. four-ply rubber belt with ⅛-in. additional rubber on the carrying side. Its speed is 200 ft. per minute.

A 35-hp. 900 r.p.m. motor drives the crusher, feeder and belt conveyor No. 1. The connection between the motor and the jackshaft is by means of silent chain; from the jackshaft to the crusher a 12-in. six-ply belt drive; and there are belt drives from the jackshaft to a spur-geared countershaft of the belt conveyor No. 1 and to a countershaft which is spur-geared to the eccentric shaft of the reciprocating feeder. The future installation will include duplicates of the feeder, crusher and belt conveyor No. 1 with the necessary driving machinery.

Belt conveyor No. 1 and the future duplicate belt deliver the coal to a set of chutes arranged with flap gates in such a manner that the coal from either of these two belts can be delivered to either one of two other belts running at right angles, one of these belts running over to an elevator close beside the wall of the first boiler room, and the other one of which will run over to an elevator in the future extension to be built alongside the present boiler room. The former belt which is now installed is known as belt conveyor No. 2, and is the same type as belt conveyor No. 1. The length, center to center of the head and foot shafts, is 55 ft. 8 in. This belt conveyor delivers the coal to the elevator boot on the ascending side which is the side toward the wall. Both belt conveyors are supported on steel framework, bolted to the concrete floor.

The elevator is 94 ft. 6 in. centers. The chains are 18-in. pitch steel strap, steel bushed, roller chains with 4 in. diameter rollers at the joints. The buckets are 17⅝x10x16 in., and they are riveted to the chain links. The elevator is inclosed in a No. 10 steel casing, properly braced and stiffened, and the chains are guided throughout the ascending and descending runs by double 6-in. channels, riveted to the inside of the casing. The casing is wider at the top and bottom where the buckets pass around the head and foot wheels, and in between these points the chains are brought closer together by means of the guides so that the casing need not be made so large. The coal is delivered at the head to a chute leading to the distributing belt conveyor over the coal bin. There is also a gate in the bottom of the chute for delivering to the bin at this point. In the future the chutes will be arranged so the coal can be delivered to either the present distributing conveyor, or the future one running in the opposite direction over the future coal bin in the extended boiler room. The elevator is driven by a 20-hp. 900-r.p.m. motor which is connected by means of a silent chain to the first countershaft, and then by means of two pairs of spur gears to a second countershaft and the head shaft respectively.

The distributing belt conveyor, Fig. 4, over the coal bin employs a 20-in. four-ply belt, with ⅛-in. additional rubber cover on the carrying side. This belt is about 105 ft. centers and runs at a speed of 200 ft. per min. The foot end is dropped down somewhat so as to bring it low enough for receiving coal from the elevator without the necessity of extending the elevator through the roof. The coal is discharged on both sides of this belt, and at any point along the length by means of a standard belt conveyor tripper running on T-rails on each side of the belt, this tripper being propelled in either direction by means of power obtained from the belt itself. This conveyor is driven by a 7½-hp. 900-r.p.m. motor, the connection between the motor and the countershaft being by a silent chain, the countershaft being spur-geared to the drive shaft of the conveyor.

The machinery is designed for a capacity of 85 tons per hour, and all details are of the latest and most improved design.

Testing Vacuum Pumps

By William D. Taylor

In power-plant practice it is advisable to check up the performance of the vacuum pumps frequently to see if they are capable of handling the amount of air for which they were designed. This applies particularly to the turbo-vacuum pumps, as the erosion of the runner blades impairs their efficiency, gradually lessening the amount of air the pumps will handle. With reciprocating pumps the test will determine the condition of the valves, glands, etc. In either case the comparison of a standard curve for first-class conditions with one obtained by test at any time, will show the ability of the pump to handle the air in the condenser and still maintain the vacuum desired.

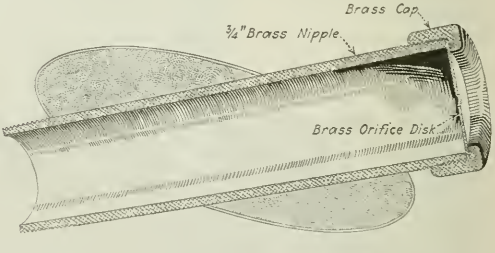


FIG. 1. ORIFICE FOR TESTING VACUUM PUMPS

The method here described is by means of standard calibrated air nozzles, "or educated air holes." A series of brass disks about $\frac{1}{16}$ in. thick and 1 in. in diameter, having holes varying from ⅛ to about ¾ in. in diameter, are used to determine the amount of air being admitted. The holes are bored accurately to size, with the edge on one side rounded so as to form a bell-mouth orifice. The inner edge should be sharp.

The apparatus consists of a ¾-in. brass nipple, as shown in Fig. 1, about 3 in. long, having a ¾-in. pipe thread on both ends, a brass cap, threaded, to go on one end of the nipple and having the largest orifice in it, about ¾ in., with a well-rounded bell mouth; and a series of brass disks, having bell-mouth orifices ⅛ in. up to ⅝ in., and which can be put in between the nipple and the cap for any size orifice desired during the test.

Preparations for the test consist in making a ¼-in. connection for a mercury column to read the vacuum, and placing a ¾-in. nipple and gate valve into the air line close to the pump for the calibrated orifice. These two connections for the orifice and mercury column must be between the pump and the valve separating the pump from the condenser, as this valve must be closed during the test.

Readings are taken of the size of orifice, vacuum obtained, temperature of the air in the room, temperature of the hurling water in the case of turbo-vacuum pumps and the barometer. Usually, the temperature of air and hurling water and the height of the barometer need be read only once for each run.

The temperature of the hurling water determines the maximum vacuum obtainable. The barometer is read so as to refer all vacuum readings to a 30-in. barometer.

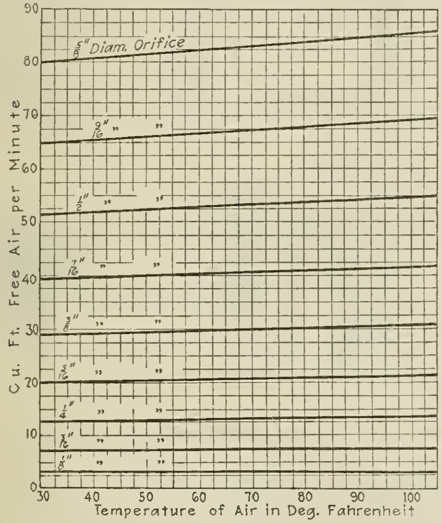


FIG. 2. VOLUME OF AIR FLOWING THROUGH ORIFICE TO VACUUM PUMP

Flieguer's formula for the flow of air through orifices may be used to calculate the amount of air handled. This formula is usually expressed as follows:

$$W = 0.530\,F\,\frac{P}{\sqrt{T}}$$

where

W = Weight of air per second;
F = Area of the orifice in square inches;
P = Pressure on orifice in pounds per square inch;
T = Absolute temperature in Fahrenheit degrees.

Now the volume of one pound of air is equal to $0.3704\,\frac{T}{P}$, using the same notation. Combining this the equation we get $Q = 0.1964\,F\,\sqrt{T}$, where Q = cubic feet of air per second. Multiplying by 60 to reduce the answer to minutes instead of seconds, $Q = 11.78\,F\,\sqrt{T}$, where Q = cubic feet of air per minute.

In using this equation it should be remembered that the absolute temperature T is equal to the temperature as read on the Fahrenheit thermometer, plus 460 deg. It must be remembered also that the value of Q given is the volume of air, at atmospheric pressure and temperature, which is flowing through the orifice per minute.

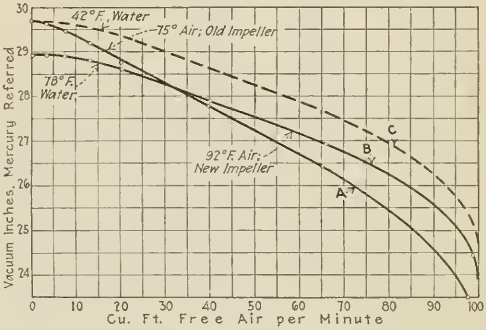


FIG. 3. PERFORMANCE CURVES OF VACUUM PUMPS

The only quantities that have to be determined, then, are the area of the orifice in square inches and the temperature of the air in degrees F. For example, assume the temperature of the air at 75 deg. F. and that the orifice having a ⅛-in. hole was used. The area F would be 0.01227 sq. in., and the value of T would be $75 + 460 = 535$. Then the volume of free air going to the pump would be $11.78 \times 0.01227 \times \sqrt{535} = 3.34$ cu. ft. per minute.

As Fliequers' formula is based on theoretical considerations, it will probably give a value a little too large. A great number of experiments, however, have shown that the error is very slight, so for most work it may be used without modification. For very accurate work the particular orifice used should be calibrated under conditions corresponding to those under which it will be used.

In using the formula the back pressure on the orifice must be less than 52.7 per cent. of the atmospheric pressure. If the back pressure is greater than this value, another and more complicated formula must be used. This latter formula has the further disadvantage of being less accurate.

The curves shown in Fig. 2 give the discharge in cubic feet per minute for various temperatures for each size nozzle. By using this curve sheet it is not necessary to do any computing at all.

Fig. 3 shows results obtained before and after changing the runner in a centrifugal vacuum pump. This also illustrates the effect of the temperature of the hurling water upon the vacuum. The first test was taken with water at 42 deg. F., the second at 78 deg. This gives a vacuum about 0.7 in. Hg. lower for the higher temperature water.

The shapes of the curves A and B show the improvement made by renewing the runner in this pump. A test taken at the same temperature of hurling water, 42 deg. F., would probably take the shape indicated by the dotted curve C.

The Electrical Study Course—Construction and Operation of Transformers

The construction of the transformer is described. How eddy currents are induced in the core and how these currents are eliminated is explained.

In THE last lesson it was shown that when two coils are mounted on a single iron core, as in Fig. 1, an alternating voltage applied to one of them will cause a similar voltage to appear across the ends of the other, even though no electrical connection exists between the two coils. Such a device is known as a transformer. In practice the core *A* is extended and bent around to form a complete loop of iron as in Fig. 2. To prevent wasting the part *B* of the core, the coils are distributed over it as well as over *A*. Moreover, it has been found that better operating results are obtained when one coil is wound over the other, instead of side by side. The result is that in actual transformer construction the coils would be placed somewhat as illustrated in Fig. 3.

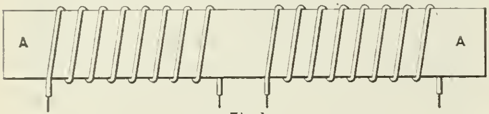


Fig. 1

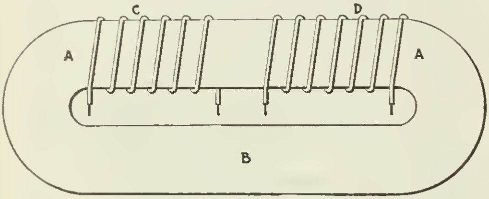


Fig. 2

FIGS. 1 AND 2. COILS ON IRON CORE

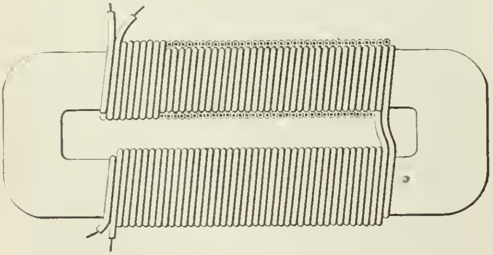


FIG. 3. TWO COILS, ONE WOUND OVER THE OTHER, ON AN IRON CORE

The iron core is not made of a single piece of solid iron bent into shape, as indicated in Figs. 2 and 3. Instead, it is built up out of many pieces of sheet iron that are stamped to the shape of the core, so that the core would actually have a structure such as that illustrated in Fig. 4. The object of this is to reduce to as small a value as possible the currents that are induced in the core, known as eddy currents. Consider a solid core with a hole *H* in it, as in Fig. 6. The shaded section comprises a complete circuit, as indicated by the arrows. It is therefore equivalent to a conductor making a single turn, whose ends are joined, as in Fig. 7. Therefore, if an alternating current flows in coil *C*, Fig. 6, it will induce a voltage in the core *A*, the same as in a turn of any other conductor. Since this single turn is closed upon itself, a current would flow through it. The hole *H* in Fig. 6 may be imagined to be made smaller and smaller, until it closed and made a solid core; however, the eddy currents would still circulate. If the core is built up of sheets of iron, as in Fig. 5, it is evident that the eddy currents in circulating around in the core must cross from one sheet to another, as indicated by the dotted lines. The resistance introduced in the path of the current by the slight air space that may be between the sheets and by the thin coating of scale on their surfaces, is sufficient to restrict the flow of current to comparatively small values, whereas the solid core will allow them to assume values that involve large losses. For simplicity of construction, the individual sheets of iron are not punched out as a complete loop, as in Fig. 8, but in one type of construction they are made in two pieces, as in Fig. 9, and assembled in two parts, as in Fig. 10. The coils—which are wound on forms—can then readily be slipped over the two parts of the core, which are then dovetailed together to form a complete circuit of iron. The appearance of a core and its coils is shown in Fig. 11.

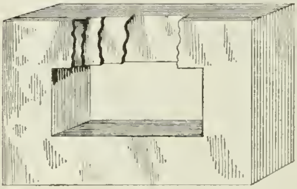


Fig. 4

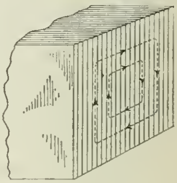


Fig. 5

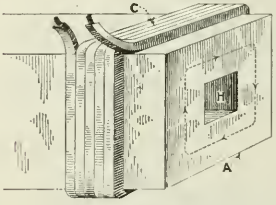


Fig. 6

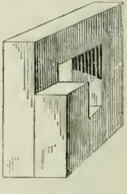


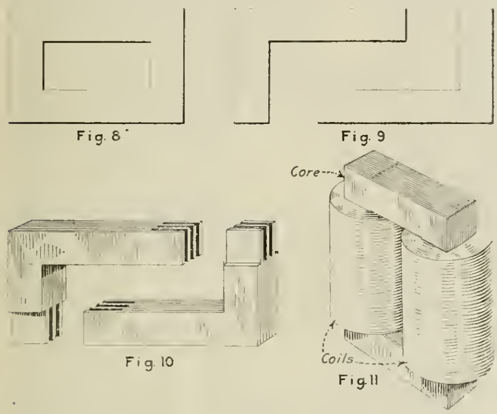
Fig. 7

FIGS. 4 TO 7. REPRESENT HOW EDDY CURRENTS ARE GENERATED IN AN IRON CORE

The volage induced in coil *D* of Fig. 2 when coil *C* is connected to a source of alternating current, is proportional to the number of turns in the coil. This must be so, since the voltage in *D* is induced by the lines of force which cut across its turns as the lines expand outward and collapse with each alternation of the current in *C*.

It is evident that the magnetic flux will induce the same voltage in each turn of the conductor it cuts, and since the total voltage of the coil is the sum of the voltages induced in its turns, it follows that the greater the number of turns, the greater must be the voltage of the coil, and vice versa. It is this fact which makes it possible to step up and step down voltages. Thus, if coil *D*, Fig. 2, has 100 turns and the voltage induced in it is 220 volts, we could get 2200 volts by substituting a coil of 1000 turns for *D* and leaving *C* the same as it is. Not only is the voltage of *D* proportional to the turns in it, but its voltage and that applied to *C* are in the ratio of the turns in *D* and *C*. Thus, if *C* has 12,000 turns and *D* has 200, and 6600 volts is applied to *C*, the voltage across *D* will be 110 volts, because, volts *D* : volts *C* :: 200 : 12,000, or volts $D = \frac{\text{volts } C \times 200}{12,000} = \frac{6600 \times 200}{12,000} = 110$ volts. This is readily explainable since the voltage applied to *C* makes a certain current flow through it. This current creates a magnetic flux which will produce in every turn of *D* the same voltage as exists across each turn of *C*.

The winding to which the source of current is applied is called the primary of the transformer. The winding in which a voltage is induced is called the secondary. If the secondary voltage is higher than the primary, the transformer is referred to as a step-up transformer; if the secondary voltage is lower than that of the primary, it is a step-down transformer. Whether it be one or the other, we have the relation, secondary voltage : primary voltage :: secondary turns : primary turns. If we substitute the quantities by symbols we have, $E_s : E_p = T_s : T_p$, where *E* stands for voltage and *T* for turns.



FIGS. 8 TO 11. CONSTRUCTION OF CORE AND COILS

We now come to that property of transformers, the possession of which makes possible their use for power-transmission purposes, which is, that the current taken by the primary is automatically controlled by the load that is connected across the secondary. In Fig. 12 *P* is the primary and *S* the secondary windings of a transformer.

How the primary current responds to the secondary load and adjusts itself to the value of the latter may be explained as follows:

The moment current begins to flow through *S*, Fig. 12, the flux in the core *T* will be affected by it. The magnetomotive force set up by the current through *S* will always be in opposition to that created by the current through *P*. For example, if at a given instant, *a* is positive and *b* negative, the current through *P* will be in the direction of the arrows, making the direction of the flux that indicated by the arrowheads on the broken lines representing the lines of force. The voltage induced in *S* will consequently be in the direction of the arrows on winding *S*, and the flow of the current will therefore also be in that direction if switch *S* is closed. The magnetomotive force set up by this current will tend to set up a flux through coil *S*, and hence will be opposed to that due to *P*. The result is that the reactance of *P* is lowered, since all reactance is due to the fact that flux is continually cutting back and forth across the conductors of which the reactance is composed. As soon as the reactance is thus reduced the current through *P* increases, until the flux through *T* is again the same as before. When the current in *S* is reduced by a change in its load, less flux is developed by it, so that there is less flux to oppose that of *P*. This causes the flux through *T* to increase, thereby increasing the reactance of *P* and consequently throttling the current through it to the point where the flux through *T* again becomes normal.

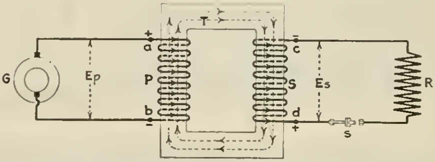


FIG. 12. SCHEMATIC DIAGRAM OF SIMPLE TRANSFORMER

The problem in the previous lesson was to find the kilovolt-ampere load and the current per terminal of a balanced three-phase system supplying 75 kw. at 0.65 power factor; the volts between terminals being 2300. Kilovolt-amperes, $kv.\text{-}a. = \frac{kw.}{P.F.} = \frac{75}{0.65} = 115$. The current per terminal in a balanced three-phase system is, $I = \frac{kv.\text{-}a. \times 1000}{E \times 1.73}$, where *E* is the voltage between terminals, then $I = \frac{115 \times 1000}{2300 \times 1.73} = 29$ amperes. It was also required to find the current in each of the generator windings if they were connected in delta, as in Fig. 13. In a delta-connected winding where the system is balanced, the current, I_w is equal to the current per terminal $I \div 1.73$, or in this problem $I_w = \frac{I}{1.73} = \frac{29}{1.73} = 16.7$, as indicated in the figure. This is also the current flowing through each load.

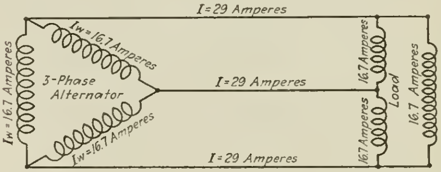
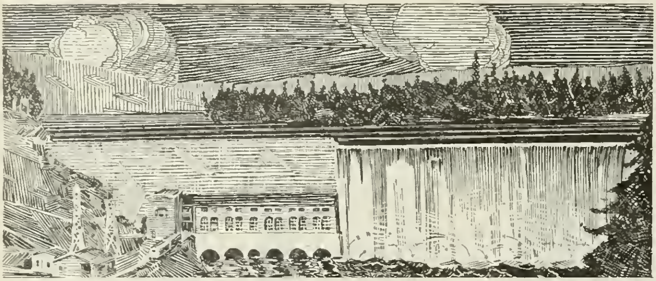


FIG. 13. DIAGRAM OF A THREE-PHASE CIRCUIT



POP'S WATER-POWER COURSE

By
John S. Carpenter

"AFTER our last talk," said Pop to Jimmy, "I was a-thinkin' about your idee of a governor which consisted mainly of a set of speed balls, a cute little throttle an' a coupla hickeys. Now, as I told you, that rig might do kinda well for a steam engine or a turbine, but for a water turbine or a Pelton wheel, never! Listen!

"These speed governors gits their cue to git on the job from a speed change. That is, we must have a speed change before the governor knows they's anything doin', an' if we has a set of flyballs that has to do considerable work in movin' heavy gates or sich like, it's gonna take a big speed change until the speed balls gits up enough centrifugal force to do the work. Jes' right here is an important point. What we calls the 'unsensitiveness' of the governor means jes' this: If a certain set of flyballs requires a 1 per cent. change in speed before it gits pep enough to move its levers an' links an' another needs only a ½ per cent. change before it will move, then the last is jes' half as *unsensitive* as the first, an' the last will pro'bly git agoin' in half the time that the first set will, helpin' to avoid trouble in the regulation of the voltage. So the point here is, the more sensitive a governor is the more delicate is the parts connected with the flyballs. An' right here it should go without sayin' that any delicate piece of machinery is teetotally unsuitable for any sich safe-movin' job like movin' the gates of a turbine. So when a speed change occurs, we has the governor balls gently callin' a husky on the job, this gent bein' called a servomotor. An' the messenger is called pilot valve. So now fix your gentle gaze on this sketch." (See the illustration.)

"This is a diagrammatic sketch of an oil-pressure governor. A good governor wouldn't be made like that —strung out all over the place—although I do remember they was a governor on the market some time ago that uster have the oil pump up in Lizzie's room, the speed balls in the parlor, the pilot valve in the kitchen an' the servomotor down in the cellar, while all through the house they was a hundred pipes. This sketch was made simple so a feller could understand it even if he did have a few college degrees after his John Henry.

"Before anything else, I'll introduce the characters in our comedy, with a few remarks on their jobs:

"The Flyballs, alias Speed Balls, etc.—The type shown ain't a good example of flyballs, 'cause they's too much friction—internal friction—in that style. Internal friction increases the unsensitiveness. The right kind of flyball is suspended on knife-edges an' has as few joints between it an' the pilot valve as possible. Every joint has some lost motion in it an' has a bad effect on the sensitiveness. We'll take up the knife-edge flyballs in detail later. An' now:

"The Oil Brake—This gent allers reminded me o' one o' them buffer states over in Europe, keepin' the scrappers apart. In ordinary conditions in power-plant operation, the load is allers changin' a bit, an' a sensitive set of flyballs is respondin' to them changes. In the case of small changes of load this constant fussin' does more harm than good, so they puts this brake on the governor to brake small changes of load, but to act when big ones come on. They is a little adjustin' screw on the side of the critter to regulate the stability of the governor, or its sensitiveness to small load changes. The less obstructed that passage is by the screw, the smaller will be the load changes the dingus will let the governor act on; an' on the other hand, when the passage is nearly closed up, it will take a big change in load before the oil brake will let the pilot valve move. Next comes:

"The Automatic Speed-Changing Device, to automatically change the speed of the wheel or turbine from no load to full load. This is necessary so that the generators driven by the turbines will share the load between 'em in proportion to their kilowatt capacity, or else you couldn't operate such generators in parallel on account of the probability of the load shiftin' from one machine to another, an' maybe burnin' out one. Usually, the speed is 2 to 2¾ per cent. lower at full load than at no load. This permanent speed drop can be adjusted on most good governors, so that in the case of a single machine or for any other reason the speed drop can be moved if they wants. Later we take up the details of this hickey. Now we have:

"The Restoring Mechanism—This feller's job is to return, or restore, the pilot valve back to its previous position before the speed of the wheel has returned to normal. If this guy wasn't on the job, the governor would be movin' the gates too fast every time an' the speed would play hide an' seek with the load, never comin' to a stable condition. The next is:

"The Remote-Control Motor—This is usually used fer remote control of the unit, the little motor bein' on the governor an' the control switch on the switchboard. This motor is geared to the restoring mechanism, the spindle bein' threaded so it moves the pivot point up or down as the operator wants. This short, fat gent is:

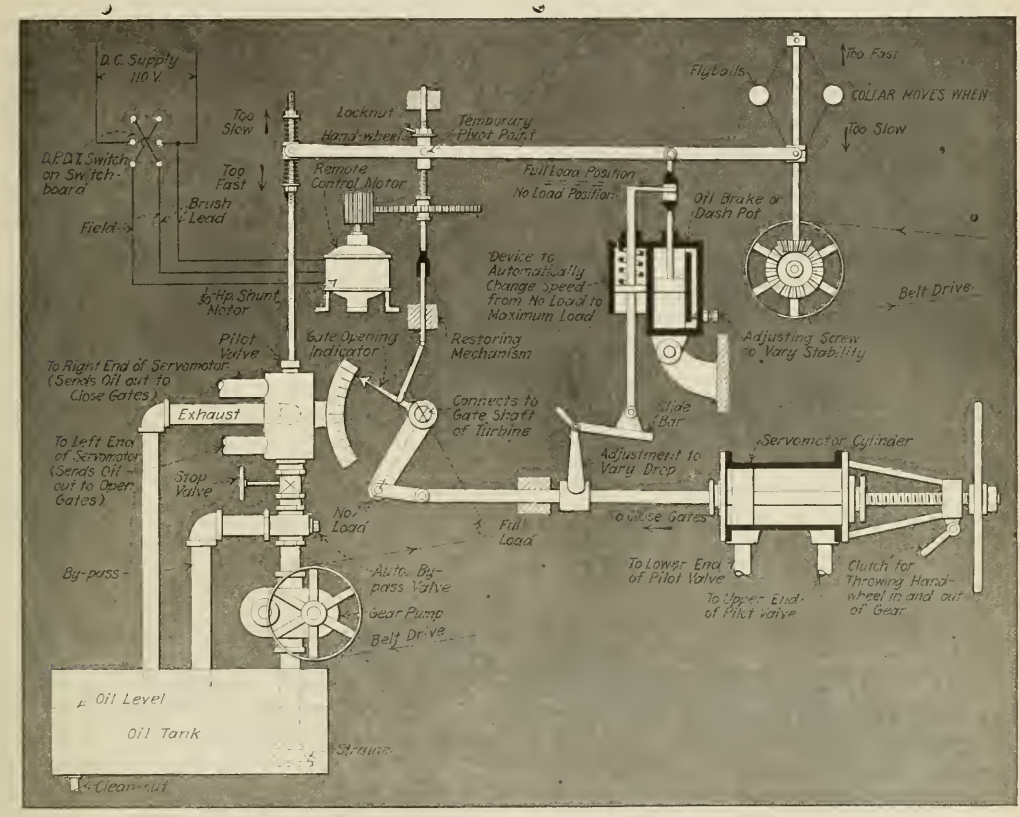
"The Pilot-Valve—He is a reg'lar henpeck, havin' to do just as his wife, the oil brake, says. When the ol' gal lets him, in the case of small governors he distributes oil to the servomotor, that husky over there with the big chest. In the case of big governors, the job is too strenuous for him an' so he passes the buck to another critter called floating piston, which does the oil-distributin'. The pilot valve usually is a small piece of nickel-steel rod, hardly more than ⅝ in. in diameter, and usually is placed inside of the floating piston when they is one. The details of this will be dooly taken up later. Now comes:

"The Oil Tank—This is jes' a steel tank, sometimes made to hold pressure, an' in this case it is jes' a reservoir. Means are provided to drain an' clean out the tank. We next have:

"The Gear Pump—In a first-class governor, this is generally made with nickel-steel gears. Like other gear pumps, the suction is below an' in the center, the discharge on top and also in the center. The stubby guy:

"The Bypass Valve—When the governor is not respondin' to a change in load, the oil is bypassed from the pump back to the oil tank. When the pilot valve moves the least little bit, the bypass valve closes and the gear pump pumps oil under pressure directly to the pilot valve. The oil pressures used vary from 100 to 300 lb. per sq. in. The wear on the valves an' the tendency to leakage is o' course much greater at high pressures, an' so most wise engineers tries to keep the oil pressure between 150 an' 200 lb. The smaller the governor the higher the oil pressure you gotta carry so the gates will be moved. Now the husky guy with the big chest:

"The Servomotor—In this cylinder is produced the force necessary to move the gates. The oil that comes from the pilot valve is carried to the servomotor by the piping shown, and the oil from the other side of the piston exhausts back to the oil tank through the pilot valve. And last:



SHOWING THE ARRANGEMENT OF THE OIL-PRESSURE GOVERNOR

"The Handwheel-Regulating Mechanism—By means of the clutch you can throw the governor out of commission an' regulate the turbine with the handwheel. This is important when you start up, 'cause you gotta git her up to speed first before you can throw the unit in on the line. The handwheel is also good if they should be any trouble with the governor. When the governor is handlin' the load, the handwheel clutch is thrown out an' the handwheel screwed back as far as possible on the piston rod, so the governor has full control."

"That's a fine description so far, Pop," declared Jimmy.

"Havin' got so far," continued Pop, "we'll now see what happens when they is, say, a 25 per cent. load change—that is, load off. The first thing that happens is that the speed balls flies out an' pulls up the lower collar. The oil brake tries to hold back for a moment because it ties the flyball collar at the pivot point an' also at the oil brake. But the force exerted by the flyballs overcomes the oil brake an' the crossbar pivots temporarily at the pivot point an' forces the pilot-valve spindle down. Jes' as soon as the pilot-valve spindle has moved enough to let a drop of oil through, the bypass valve closes an' sends pressure oil around to the right-hand end of the servomotor, or oil cylinder. This gent now gits on the job and moves the piston an' gate-shaft lever toward the closed position. In so doin' it raises the little lever on the restoring mechanism, liftin' up the pivot point an' carryin' with it the pilot-valve spindle. That natchelly shets off the oil that is agoin' 'round to the servomotor, an' as the pilot valve covers both the closin' an' the openin' ports, the piston is now locked in place, for the pipes an' servomotor is filled with oil. The oil that was on the other side of the piston was returned to the tank by way of the pilot valve an' the exhaust pipe."

"Just tell us what the automatic speed-changing device does and how it works. That thing looks mysterious."

"Well, you sees that slide bar? That does the trick all alone. The servomotor is shown in the closed position and the slide in its lowest position. I told you before, when introducin' the characters, that at full load the wheel should run a bit slower than at no load. The flyball collar must move down to increase the speed, an' this is jes' what it should be prevented from doin'. Therefore, we arranges the slide so that at full load the horizontal bar strikes the oil-brake piston rod in the hole that the bar works in an' so prevents the rod from movin' down, since the horizontal bar is supported rigidly on the slide bar. The slide bar is shown with a locknut so the speed difference at full load can be changed, if necessary, or entirely removed."

"What is that spring in the cylinder of the speed-changing device?" asked Jimmy.

"Simply to keep the slide agin the slide bar. An' the gate-openin' indicator does jes' what it says—shows how much them gates is open." Pop decided to light up as he noticed that Jimmy made remarkable progress with the cigar box.

"Now tell us how you start up a unit with such a hickey for a governor. I suppose you've got to be a college professor to run it."

"Not on your tintype!" assured Pop, blowing great clouds of smoke toward Jimmy in self-defense. "The designers of this governor knew that once in a while a flathead would git to run it, so they laid awake many nights a-thinkin' how they could make it fool-proof. They never quite did the trick, but it must be said the average run of operators has brains. This is how we does it:

"See that the stop valve below the pilot valve is closed. Throw in the handwheel clutch and move the gates to the closed position, if not there. See that the locknut on the restoring mechanism is up as high as it will screw, an' then raise the handwheel under the locknut as far as it will go. Now start the turbine slowly by means of the handwheel on the servomotor an' gradually bring it up to speed. Throw out the handwheel clutch and screw the handwheel as far toward the end of the piston rod as it will go. All this while the oil pump has been pumpin', but has been bypassin' the oil back to the oil tank through the bypass valve. Now open the stop valve, which will let oil go to the servomotor. By screwin' down the handwheel on the restoring mechanism spindle, bring the speed to normal an' then lock the handwheel with the locknut. The governor is now handlin' the load."

"And the stopping of the unit?" continued Jimmy, helping himself to another cigar.

"Why, you screws up the handwheel an' locknut on the restoring valve spindle as far as you can, throw in the clutch on the servomotor handwheel, shut the stop valve an' close the gates."

Early American Steam Boilers

By HUGH G. BOUTELL

Description of boilers that were used in pumping stations of Philadelphia at the beginning of the last century, particularly a wooden boiler installed in the old Centre Square pumping station, employing a steam pressure of 2½ lb. and supplying a beam engine whose frame was also of wood.

There is at least a certain amount of historic interest in a description of mechanical appliances designed in the early days of steam engineering and now, having fulfilled the part they were designed to play, relegated to oblivion. Usually there is little in such a description that will directly aid the engineer in his everyday work, but on the other hand the contrast which such reading is bound to bring to his mind between obsolete and present practice is sure to increase his admiration for the great advance made in the field of mechanical engineering since the introduction of steam power in the United States.

At the beginning of the last century there were very few steam engines of any kind in this country, and most of these were of the low-pressure condensing type, as introduced by Watt toward the end of the eighteenth century. A few of these engines were erected in manufacturing plants in the United States, and some were set up in the water-works for supplying the cities of New York and Philadelphia.

In the latter city two pumping stations were erected, one at the Schuylkill River and one at Centre square, both having been completed about the year 1801. The Centre Square plant contained a single-beam engine, having a steam cylinder 32 in. diameter by 6 ft. stroke and driving a double-acting pump having a cylinder 18 in. diameter with the same stroke as the engine cylinder. An excellent description of the plant was presented in a paper by Frederick Graff, C. E., before the Franklin Institute in 1876. It is somewhat surprising to learn that the main beam, supports for the main bearings, flywheel arms and other parts were made of wood, but it seems hard to believe that the boiler by which the engine was supplied with steam was also constructed of this material. Such, however, was the case, and Mr. Graff describes the construction as follows:

"The boilers were rectangular chests, made of white pine planks 5 in. thick; they were 9 ft. square inside at the ends, and 14 ft. long in the clear, braced upon the sides, top and bottom with oak scantling 10 in. square, the whole securely bolted together by 1¼ in. rods passing through the planks. Inside of this chest was placed an iron firebox 12 ft. 6 in. long, 6 ft. wide and 1 ft. 10 in. deep, with vertical flues, 6 of 15 in. diameter and 2 of 12 in. diameter; through these the water circulated, the fire acting round them and passing up into an oval flue situated just above the firebox, carried from the back of the boiler to near the front, and returned again to the back, where it entered the chimney. This firebox and flue appear to have been at first made entirely of cast iron; then a wrought-iron firebox was made, the flues still being of cast iron. This was not satisfactory on account of the unequal contraction and expansion of the two metals causing leakage, and eventually wrought-iron flues were also put in.

"Great advantage was at the time supposed to be gained by the non-conducting powers of the wood, and also by the vertical flues in the firebox."

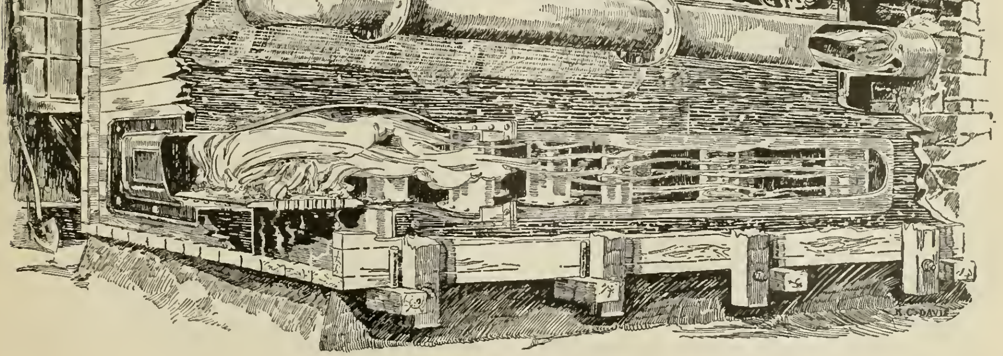
At the time this boiler was constructed, wood had been used with considerable success for making vats used in distilling, and it was supposed that wooden boilers, having to contain only comparatively pure water and steam, would be even more satisfactory. The steam pressure carried by the boiler in the pumping station at Centre Square is recorded as having been 2½ lb. per sq. in., but even at this low pressure the boilers gave trouble. Apparently they remained in good shape below the water line, but the steam rotted the wood very quickly, for a description written by Mr. Benjamin H. Latrobe, at the time the boiler was in use, contains this odd comment: "That there is a great saving" (in the use of wood over iron boilers) "is certain; and while the wooden boilers continue steam-tight (for that part which contains the water gives no trouble), they are certainly equal, if not superior, to every other. The wood, however, which is above the water, and is acted upon by the steam, seems to lose its solidity in the course of time, and steam leaks arise in the joints, and wherever a bolt passes through. The joint leaks may for a considerable time be easily stopped by screwing up the bolts that hold the planks together; but it is not so easy to cure the bolt leaks, for the bolt, when screwed up, bends the top or the sides inwards, and forces new leaks, either along the corners, or at some other bolt hole. I do not, however, believe that everything has as yet been done, which could be done, to obviate these defects. A conical wooden boiler hooped would not be subject to some of them: such a one has been applied by Mr. Oliver Evans to his small steam engine. During two years which have elapsed since the boilers of the public engines have been erected, much has been done to improve them; whether the last boiler will prove as perfect in its woodwork, as it is in its furnaces and flues, is still to be ascertained by experience. At present nothing can work better.

"I will only mention one other circumstance, the knowledge of which may prevent similar mischief. In the first boiler erected in Philadelphia, oak timber was used to support the sides, bottom and top of the boilers, the plank of which was white pine, 4 in. thick. In less than a year it was discovered that the substance of the pine plank to the depth of an inch was entirely destroyed by the acid of the oak. Means were then used to prevent its further action, by the intervention of putty and pasteboard; and in most cases by substituting pine timbers in the place of oak."

As the wooden boilers did not prove satisfactory, after a few years of service, they were replaced by others made of cast-iron plates which remained in service until both the Schuylkill and Centre Square pumping stations were discontinued due to opening the plant at Fairmont in 1815.

This station contained a beam engine similar to the ones used at the earlier plants and supplied with steam at 2½ lb. pressure by a cast-iron boiler. In the same station Oliver Evans erected a high-pressure pumping engine about 1817, and provided it with four cylindrical boilers made of wrought iron, 27 in. in diameter and 27 ft. long. Mr. Graff records that steam was often raised in these boilers to a pressure of 220 lb. per sq. in., which would, of course, be considered fairly high pressure in stationary work today. I have been unable to ascertain the exact construction of these boilers, but judging from the dimensions it would appear likely that they were simply plain cylinders without flues of any kind.

It was apparently the idea of those in charge of the water-works to determine the relative merits of high and low pressure steam for pumping engines, but it is doubtful if much of a comparison was made; as the high-pressure boilers exploded on June 20, 1818, and killed three men. The Fairmont steam pumping plant was shut down in 1822, when a new station using water power to drive the pumps was completed. The buildings of this plant still stand on the bank of the Schuylkill River, though all trace of the machinery which they once contained has been removed.



A Perspective of the Fuel-Oil Situation

By CHARLES H. BROMLEY
Associate Editor of Power

Here is an Article Your Manager or Directors Will Want To Read. Hand It to Them

What is there to all this talk about fuel oil?

Why is it creating such widespread interest?

Where is it applicable, and under what conditions?

What are its sources and what about the continuity of supply?

Wherein does it surpass coal in the matter of cost and boiler performance?

How does it influence the labor situation in one's power plant?

What problems are connected with its storage and handling?

These are some of the more pressing questions engineers are asking. The article herewith aims merely to tell a few things that may help those who are asking such questions.

In the first place practically all fuel oil used in furnaces in the United States, excepting in some sections on the Gulf and in California, comes from Mexico, chiefly out of Tampico. As delivered to the consumers, it is topped; that is, the naphthas, gasolines and kerosenes have been driven off. This does not materially decrease its value for boiler furnace fuel as compared with crude petroleum. In fact, topping improves it as a boiler fuel, because the highly volatile constituents are no longer present to give trouble or create undue risk in storage and handling.

The widespread interest in oil as fuel arises because of several reasons. The all-impelling one is, of course, cost as compared with coal. Then, too, coal is difficult to obtain. The other day a large plant on the Boston waterfront received a shipment of New River coal. It was the first in many months—in Boston, the chief port to which New River coal used to go. The purchaser never had anything else in his bunker until recently. In fact, compelled to accept coals high in sulphur, he has had fires in the wooden bunker, something unknown here with the coal formerly available. This plant will be ready to burn oil as soon as the concrete oil-storage tank is sufficiently dry.

Europe is shivering, its industries are handicapped, its hotels made inconvenient and uncomfortable—all because of lack of coal. Of money Europe has much, and it is willing to pay, and is paying, considerable for good American coal. At this writing the freight rate from New York on coal is $26 on 1000 tons displacement to Marseilles, $31 on 800 tons to Venice and $25 on 1000 tons to Hamburg. So it is well worth while, if one has steamers, to use them in this Atlantic trade. And further, because of the freight rate, one aims to transport only the highest-grade coal. The more heat units per ton of cargo space the relatively lower the freight rate, for high-grade coals always bring comparatively high prices.

In fact, New England engineers, the oldest and largest users of America's high-grade coal, are asking if perchance this coal has not about petered out. Many seem to believe that for them it has. But a survey will show that there is much of it in West Virginia, and that, while disturbing, the situation is not as serious as some seem to believe.

And the situation does not look as though it was soon going to improve materially. Perhaps this is reflected in the action of one large company on the Atlantic Coast. The present New England Fuel and Transportation Co. is one of the largest, if not the largest, coal company in New England. It has gone into the oil business through the newly organized Beacon Oil Co., with offices in Boston. This company is now building a refinery on tidewater at Everett, Mass., with a capacity of 6000 bbl. per day and storage for 6,000,000 bbl. This plant will soon be finished. The crude will come from Mexico. Two railroad connections are provided, the Boston & Maine and the Boston & Albany.

Farther down the coast at East Branford, Mass., near Fore River, the Massachusetts Oil Refining Co. is building a large refinery. The capacity figures I do not have, but understand they are large.

But of all recent moves in the oil business none has created such a stir as that of the Standard Oil Co. of New York. This company has just purchased a mile of harbor front at East Providence, R. I., the property extending back for three miles. Here a great tank farm will be erected, making Providence perhaps the largest in the world. The investment so far represents $18,000,000.

The Mexican Petroleum Corporation, which may be said to be the big pioneer in fuel oil along the Atlantic Coast, has established large storage stations at Providence, Boston and Portland. Before these were built, stations had already been conveniently located farther south and on the Gulf. This company's activities had done much to further oil before the war; but when the conflict broke in on us, the Government took over most of the company's tankers. All but two of these have been returned, and now the company has 19 tankers taking oil out of Tampico. The war stopped fuel-oil development too because so much was required for the Allied Navies. Enough could not be rushed to Europe. In fact, the shortage was so great that, when American naval officers got abroad to prepare for our war activities, they found it necessary to send coal-burning battleships. So the intense application now going on was to be expected—was expected, as may be seen by reference to articles in *Power* at the time.

Where is it applicable and under what conditions?

Oil is the cleanest, most convenient fuel used. It is applicable wherever coal may be burned in furnaces. It may be used in small as well as large power plants.

Wherein does it surpass coal in the matter of cost and boiler performance?

Price of oil alone is not paramount, particularly in a plant changing from coal to oil. The cost of equipping for oil, including adequate storage, is a vital factor, though obviously there are others. But as a fuel, as a steam producer, roughly 4½ bbl. (42-gal. barrels) are equivalent to a long ton of good coal, or a pound of oil equals a pound and a half of good coal.

But oil is better than that. That value is based on the relative heat units in coal and oil. Complete combustion means the complete consumption of the combustible in a fuel brought about by the supply of oxygen of the air. Perfect combustion is the use of only as much oxygen as is theoretically required to completely burn the fuel. Fuels must be gasified before they burn, and obviously oil, which has no ash, which does not form a fuel bed with clinkers, may more easily be broken up, atomized and gasified than coal. And so with oil each carbon atom the more readily finds the two oxygen atoms needed for its complete combustion, for combustion is good or poor according as the mixture of air for combustion and gases for combustion is intimate and rapid and the air in not too great excess.

Because of this mechanical advantage which oil possesses over coal it gives, in the average plant, a greater combined boiler and furnace efficiency by from 6 to 8 per cent., all other conditions being equal. That is, with a given plant, load and labor, the over-all efficiency will be higher for oil by the amounts given. But be it understood that experience shows that materially no greater combined efficiency is possible with oil than with coal. A first-class fireman, with first-class stoker and coal adopted and of good quality, can show practically as good results as one can with oil—but it cannot be maintained for so long.

How does fuel oil influence the labor situation in one's plant?

It may not affect it at all or it may astonishingly minimize it, depending upon the number of active boilers in service in the plant, whether the boilers are hand- or stoker-fired, and the quality of coal used. It is increasingly difficult to get good firemen, particularly in hand-fired plants. Boiler-room labor troubles are usually like the poor—always with us. One competent man can handle four times as many boilers using oil as he can using coal. Of course the ratio is but the roughest kind of comparison, for it is plain that a plant having three boilers and using one or two men could not reduce its labor charge by changing from coal to oil. On the other hand, the American Woolen Mills in Lawrence, Mass., large steam users, reduced their boiler-room force more than two-score men for the same steaming capacity when they changed from coal to oil. There are some small plants where the engineer may do his own firing with oil where he could not with coal; but no reduction in labor charge should be expected where but a few men are employed in the boiler room. Oil is a fuel that men like to use; it is clean, there is no dust, no inconvenient handling, no ashes to remove and no heavy lifting or hauling connected with it. It contents the man who uses it, and here lies its power as a reducer of boiler-room labor troubles.

What problems are connected with its storage and handling?

It depends upon the location of the consumer, whether there will be problems worthy of the name. The contracts of the companies supplying the oil usually require that the purchaser's storage facilities be sufficient to hold three weeks' supply. This is not always necessary. We are surely going to see the oil companies establish and maintain tank-truck service in far larger volume than at present. This will simplify the storage question for the consumer. The number of tank cars (railway) is increasing rapidly, and steps are being taken to facilitate their movement to consumers not on tank-truck routes or on tidewater. In the writer's opinion storage and delivery are things to worry about only in exceptional cases.

For the small plant the steel storage tank is popular, while the large and medium-sized plant often finds concrete desirable. Experience is showing, however, that the actual cost of constructing storage tanks is in almost every case higher than the estimated cost.

The insurance regulations for fuel oil are, on the whole, easy to meet. At least one large company is now revising its regulations, and these will help rather than make it more difficult for the consumer. Storage tanks are required to be underground, the lowest point in the oil-burning system, and properly vented.

What about the continuity of supply?

Here is the question that so many run smoothly to and then come to a full stop with more or less shock. Nobody knows much about it. But when an oil company is willing to make a three or more years contract and shows that during the war it never failed to make delivery to a customer, that there is every reason to believe there is more oil available in the ground than even they hoped, that many years of much-disturbed political conditions in Mexico have failed to shut off the supply—when these facts are known, one is well on the way toward being convinced of the value of oil as a boiler fuel, though the careful man will want to go further with his studies. This is particularly true of the man responsible for large industrial power plants and public-utility stations.

Obviously, oil must not only be available in sufficient quantity and delivery made with satisfactory regularity, but for the large consumer the supply must be assured at least for a period long enough to raise no question about making the investment pay. There enters into this the question of price of oil and price of coal. It is plain that the oil must be low enough in price to pay for the change-over investment in a reasonable time. In the large plant the reduction in labor charge effected by oil will help materially when credited to the investment, as it should be.

Naturally, local conditions will greatly influence the magnitude of the investment in storage facilities, the greatest item of expense in the change from coal to oil. For example, the Narrangansett Electric Lighting Co. is now installing oil-burning equipment. The plant has modern underfeed stokers and is but a few years old. It is on tidewater, and coal delivery is by barge. Huge storage depots of several petroleum companies are virtually next door. The Standard Oil Co. has just purchased a mile of water front across the river and here will erect one of the largest tank farms in the world. This company has the Narragansett Electric Co's contract. It is quite certain that no large storage capacity need be provided by the purchaser in this case. There are some other large stations on the Atlantic waterfront almost as favorably situated. Certainly, these should be able to make the change at a cost very much lower than the station less favorably situated. Fuel oil is a zone proposition.

The 1919 production of Mexican petroleum will perhaps exceed 80,000,000 bbl.; the exports for the first six months of this year were 35,000,000 bbl. Surveys have placed the potential production of Mexico at 1,000,000 bbl. per day. Today Mexican wells each give from 10,000 to 60,000 bbl. per day. Reports have it that the oil interests are now ready to spend $100,000,000 on further oil developments in Mexico. From the figures in this article and others available, it is evident the oil companies are backing up their faith with money.

The navies of the world, also the merchant marine, more and more rely upon oil as a fuel. At least half the vessels of the Emergency Fleet Corporation use it. Oil is fast becoming the dominant fuel of the sea. Sea traffic is sea power, and sea power is world power; not necessarily for armed conquest, but certainly for commercial conquest. Oil, then, is extremely vital to a nation's well-being. It bears a close relation to its stomach and its pocketbook, and therefore to its commercial, diplomatic and war departments.

Great Britain, which has seldom been accused of shortsightedness in its world-wide commercial affairs, has long been busy acquiring control of the world's petroleum resources. One is no longer surprised to learn that control of petroleum fields was one of the chief factors in General Allenby's Palestine Campaign. There is huge foreign capital invested in Mexican oil by the two most powerful countries on earth. They are bound to protect those of their citizens who have vested interests there. Even more, our Monroe Doctrine makes it obligatory upon the United States to do so for ourselves and all foreign investors.

Now then, is it to be imagined that these powers will accept any really unjust and harmful political action by Mexico? Of course not.

But Mexico has just as much right to nationalize her oil fields as England has to nationalize her coal fields. If she does, she must do so with extreme caution, and equity and justice to foreign investors, lest some day soon the forces which seemingly have exerted every effort to bring about a state of war that Mexican oil fields may be made another Saar Valley, will have had their way.

Politically, it is as plain as a pikestaff that Mexico must be eminently fair with her foreign investors or suffer, to her, a crushing economic loss. Needless to say, she is entitled to the same treatment from her powerful neighbor.

Atomic Energy as a Source of Power

A special cable to the New York *Times* says: Sir Oliver Lodge, speaking before the Royal Society of Arts, amplified a lecture on atomic energy which he delivered in Birmingham in September. Predicting that a time would come when atomic energy would supersede coal as the source of power, Sir Oliver said:

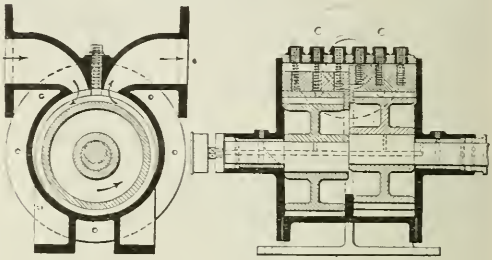
> A radium atom firing off a particle which turns out to be a positive charged atom of helium is like a two-ton gun firing a 100-pound shot. Before it has exhausted its ammunition, it fires off five such projectiles and then settles down into a quieter existence as lead or something chemically indistinguishable from that substance.
>
> It would seem that all substances of very high atomic weight are liable to behave in this way. It is only a question of degree, and it is not by any means their whole energy that they thus exhibit; it is the energy they expend and get rid of—their waste energy—that we perceive. When their active transformations have ceased and left them in a stable state, like lead, gold, silver, copper, iron, or any common element, we are not to suppose that because they are quiescent, therefore they have no store of internal energy. Anyone looking at cordite might think it harmless; and it is till suitable stimulus is applied.
>
> I think we are on the brink of a discovery. It may be a century, but I do not suppose our descendants will be using chemical energy. Instead of burning 1000 tons of coal, they will take energy out of an ounce or two of matter.

Squeegee Rotary Pump

A type of pump, the principle of which is not new, but which, as designed, has carried out a new idea, is known as the "Squeegee" rotary pump, and according to *Engineering* is manufactured by the Avamore Engineering Co., Ltd., of Queen Victoria St., London. The pump is of the positive type and is made at present in six standard sizes. Its leading features are simplicity of design and high speed, and owing to the fact that the rotor has a rolling motion imparted by the casing, the wear is reduced to a minimum. It is suitable for pumping gritty or muddy water and, by using an all-metal roller, oil.

The pump consists of six main parts—the casing, two cover cases, shaft and two rotors, which in the standard design are covered with India rubber. The casing and rotor disks are generally made of cast iron, but bronze and other special metals can be used. The shaft is of steel and is carried in two bearings. The eccentrics, which are solid with the shaft and have only a small throw, impart movement to the rotors, which are a loose fit on the eccentrics.

The displacement is caused by the rolling of the rotors when driven around by the eccentrics on the main shaft; but as this shaft is rotated in an anti-clockwise direction, as shown by the arrow in the illustration, the rotor rolls around in the same direction, but, being smaller in circumference than the track in the casing, it rotates in a clockwise direction, but only in proportion to the difference between the circumference of the casing or track and that of the rotor. The point of contact between the rotor and the casing is constantly rolling forward in an anti-clockwise direction. The shaft may be driven from either end and in either direction, and for this reason the inlet and outlet connection are interchangeable and therefore are not specially marked.



SECTION THROUGH THE PUMP

Small deflecting valves, one for each rotor, are placed in the upper portion of the casing, and are kept in position against the rotor by the small springs shown. The pumps are made in sizes from 1 to 4 in. in diameter pipe connection, with a capacity of from 700 to 13,000 gal. per hour when run at 1250 r.p.m. and 720 r.p.m., respectively. The pump may be run at any speed up to the maximum and will deliver a proportional quantity of the liquid being pumped against any head within the limit of 100 ft. for the smaller sizes and 150 ft. for the larger.

Twenty-five years ago the highest voltage used was 11,000; two years later, or in 1896, this was increased to 22,000. Transmission-line voltages have kept increasing in value until in 1912 the 150,000-volt line was put in operation in California on the Big Creek development of the Pacific Gas and Electric Co. The present indications are that the use of 220,000 volts for long-distance transmission of electric energy may be looked for in the very near future.

The first 1000-volt transformer had a capacity of 9 kw. and was built 30 years ago. The design of 35,000-kv.-a. transformers for 220,000 volts is being looked upon as a possibility of the near future.

A Self-Adjusting Spring Thrust Bearing

A careful study of the difficulties experienced with the types of thrust bearings used in supporting the heavy loads of waterwheels and electric generators driven by them, has led to the design by the General Electric Co. of the flexible spring thrust bearing described here. It is now used in G-E vertical alternators.

DEVELOPMENT of machines in sizes not long ago unthought of, with rotating elements of great weight, has brought about complications in the details of bearing design. The manufacture of huge, hydraulically actuated direct-drive generators has forced attention to the method of supporting their great revolving parts. A single thrust bearing on these vertical waterwheel-driven generators has to support the rotor, the waterwheel and the thrust of the water. One of the serious difficulties encountered in the development of larger sizes was a satisfactory means for supporting these great weights. These loads have caused considerable trouble with the bearings in use, such as the wiping of the babbitted surfaces upon starting and stopping, sometimes requiring the rescraping of the surfaces or sometimes the installation of new parts.

This spring-supported thrust bearing automatically adjusts itself to unequal loading due to inaccuracies in workmanship or alignment. The design is based on a theory which is fundamentally correct, and which enables the production of a bearing much more simple to make than the standard forms of thrust bearing previously used. While some other types of bearings may be carefully adjusted when installed, a distinctive feature of the spring-supported bearing is that it will automatically adjust itself while in operation, if there is a loss of alignment due to the settling of the foundation or to other causes.

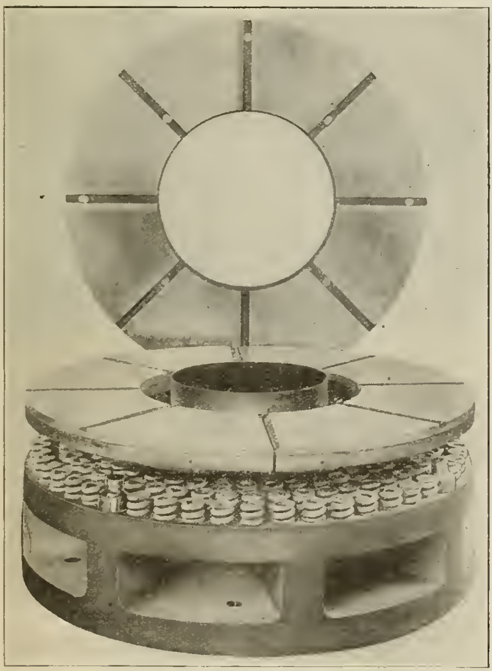


FIG. 1. ASSEMBLY OF THE THRUST BEARING

On large machines the machining of the part is not as accurate as on small units. With an oil film between the thrust-bearing surfaces of about three ten-thousandths of an inch, it is evident that even with good machining and erection, very severe conditions may exist for any thrust bearing without a yielding support.

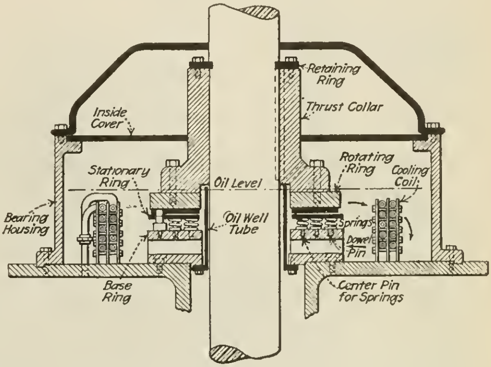


FIG. 2. SECTION OF THE SPRING THRUST BEARING

To maintain a film of oil of fairly uniform thickness in other types of bearings now in use, it is necessary that the parts which form the bearing surface should be exceedingly rigid so that the deflection of the bearing surface shall be small. It is for this reason that the shells of ordinary journal bearings are made stiff so that they will do some supporting even at the ends. The ideal condition would be to have the deflection of the bearings and shaft the same, but in practice this cannot be accomplished. The spring thrust bearing approximates this condition, and it is based on the idea for a bearing surface which is so yielding, flexible and elastic that it may follow the irregularities of the rotating surface without creating at any point a unit pressure sufficient to destroy the oil film.

The heat generated between the rubbing surfaces of the bearing is dissipated in two ways: First, by transmission through the runner and babbitted ring to the oil; or, second, by the oil passing between the surfaces. Assuming that the oil film is three ten-thousandths of an inch in thickness, and that the velocity of the oil is one-half that of the rotating surface in a thrust bearing 44 in. outside diameter, running at 200 r.p.m., without any grooves in the runner, the rate of flow in the film is about one-third of a gallon per minute.

This is but a small proportion of the cooling oil required, which indicates that the greater part of the heat passes through the metal plates. The thin babbitted ring used in this bearing will transmit this heat at a much higher rate than will a thick plate, and thus the temperature at the rubbing surfaces is reduced. On the other hand, with eight grooves in the runner, any part of the babbitted surfaces is swept over by a stream of cold oil at a high radial velocity, 25 times per second.

A spring thrust bearing of typical design is shown in Figs. 1 and 2. The bearing consists of a runner of a special grade of cast iron resting on a thin steel disk with a babbitted surface. This babbitted ring, in turn, rests on short helical springs and is held against rotation by dowel pins. The high base casting shown is used in connection with a deep housing in case it is desired to increase the amount of oil in the surrounding bath.

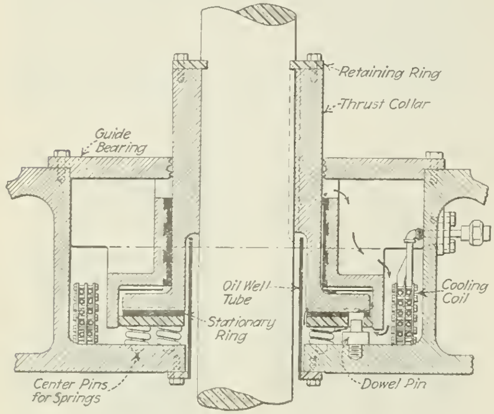


FIG. 3. COMBINED GUIDE AND SPRING THRUST BEARING

The tube in the center forms a retaining wall around the shaft for the oil. The springs shown are wound of ½-in. round wire and have an outside diameter of 2 in. and a free length of 1½ in. Under load the springs close about 3/32 in., and the total pressure is distributed upon all of them.

The cast-iron runner is located on the underside of the thrust collar, which is fastened to the top end of the shaft by means of a retaining ring. The bearing surface of this runner is finished with extreme accuracy and is given a high polish. The babbitted surface upon which this runner revolves has radial oil grooves cut in it, and it is cut entirely through in one of these grooves to prevent any tendency to dish or warp under changes in temperature. This surface is given a tool finish in the shop. It is not necessary to give this babbitt surface any further finish such as hand scraping to the iron runner or to a surface plate, which is generally done in the case of the other types of bearings.

The springs are designed to be stressed to only a very small proportion of their capacity, which insures against the possibility of their taking a permanent set. The oil-retaining tube in the center is welded to a supporting ring, which is bolted to the base ring.

By means of the yielding support furnished by the springs, it is possible to avoid excessive pressure at any point on the surface of the bearing. Thus it has been found safe to run at a much higher unit pressure than when there is no method of relieving an undue stress which may occur over a small part of the bearing.

In the absence of dirt and grit, bearing failures are usually due to the squeezing out of the oil film. The pressure necessary to accomplish this is much greater than is generally supposed. In one case a pressure of 5000 lb. per sq. in. was carried for several hours without any damage to the babbitt surface.

A type of thrust bearing which permits the use of high pressures has a much better efficiency than one in which a lower unit pressure is used. In a bearing having a continuous oil film, the only friction loss is that due to the viscosity of the oil, or its resistance to the continual shearing of the film. Therefore the friction in the bearing lessens with the decrease in the area of the film.

With the use of high unit pressures upon thrust bearings the mean diameter may be reduced and consequently the rubbing speed is also reduced. The coefficient of friction is also lowered owing to reduced speed and an oil film of less area.

The following table shows a comparison between a large and a small bearing with the same total load. The advantage in selecting a type of bearing which permits the use of high unit pressures is apparent.

	Small	Large
Bearing number	1	2
Revolutions per minute	200	200
Total load, lb.	300,000	300,000
Outside diameter of bearing, in.	35	46
Inside diameter of bearing, in.	17.5	17.5
Net area, sq. in.	600	1200
Pressure, lb. per sq. in.	500	250
Average rubbing speed, ft. per min.	1370	1670
Coefficient of friction	0.0018	0.0033
Kilowatt loss	16.7	38
Horsepower loss	22.5	51

The friction loss in the small bearing is less than half of what it is in the large bearing.

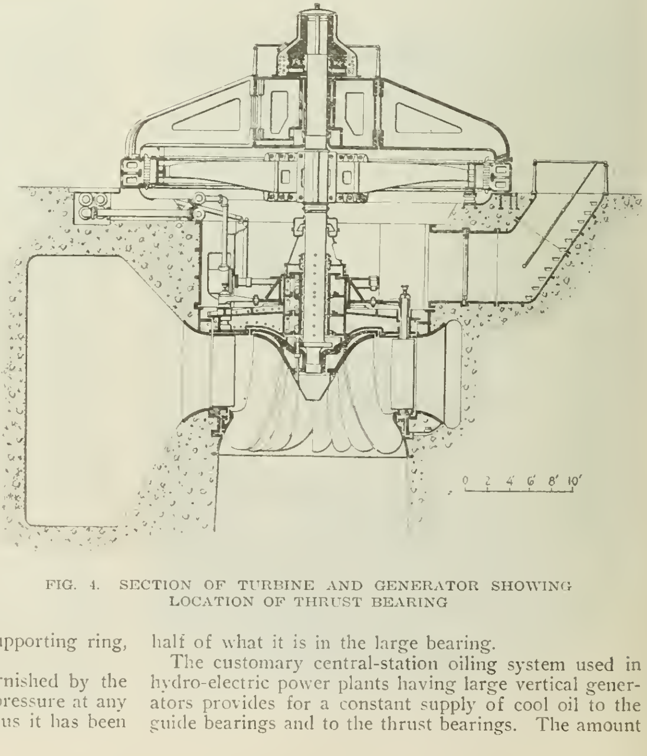


FIG. 4. SECTION OF TURBINE AND GENERATOR SHOWING LOCATION OF THRUST BEARING

The customary central-station oiling system used in hydro-electric power plants having large vertical generators provides for a constant supply of cool oil to the guide bearings and to the thrust bearings. The amount of oil to the guide bearing is small compared with that to the thrust bearing. The quantity of oil circulating from a station oiling system to the thrust-bearing housing of a large generator, according to the usual method, requires an extensive equipment of large pipes, pumps, filters and tanks with coils for cooling the oil at some point in the system. Since the practice of passing the oil through the bearing housing to remove the heat generated between the rotating surfaces involves the handling of so much oil, a more simple system has been adopted.

For the proper lubrication of a thrust bearing the only requirement is a bath of clean oil, from which the heat is being removed as fast as it is generated in the bearing. The General Electric Co. has introduced the use of cooling coils, immersed in the oil in the bearing housing, through which water is circulated. These cooling coils abstract the heat from the oil surrounding the bearing, and a considerable saving in expensive equipment has been effected by the adoption of this method.

The oil is circulated about the cooling coils by the pumping action of the radial grooves in the rotating surface of the thrust bearing.

This method of cooling the oil was adopted at the Cedar Rapids Station for the last two units installed there. Note the position of the water-cooling coils in the spring thrust bearing housing.

For use in the smaller-sized vertical generating units a combined guide and spring thrust bearing has been designed. This retains all the advantages of other spring supported thrust-bearing features, and at the same time provides a guide bearing, both bearings being contained in the same housing and lubricated and cooled by the same oil. The cross-section, Fig. 3, shows the constructional details of this combined guide and spring thrust bearing. The rotating grooves of the bearing pump the oil through the guide bearing, thereby insuring it an ample supply. The oil flowing down from the top of the guide bearing comes in contact with the copper coils, which abstract the heat from it. It is then drawn in through the radial grooves of the thrust bearing. The combination of the guide and thrust bearings in this manner effects a considerable economy of space.

At Gatun Locks hydro-electric station, Panama Canal, there are three units in which spring thrust bearings have replaced another type which was formerly used there. A new and larger unit, which has been added to the original equipment, is also provided with a spring thrust bearing.

Figs. 4 and 5 show generating units equipped with the combined guide and spring thrust bearing. A good idea of the economy of space effected by this combination may be obtained from the photograph.

In addition to their use on generators, these bearings are in use on ships to take the thrust of the propeller shaft; and in these installations the results have been uniformly satisfactory. The principle on which the design of the spring thrust bearing is based is one which can be practically applied to the solution of many bearing problems.

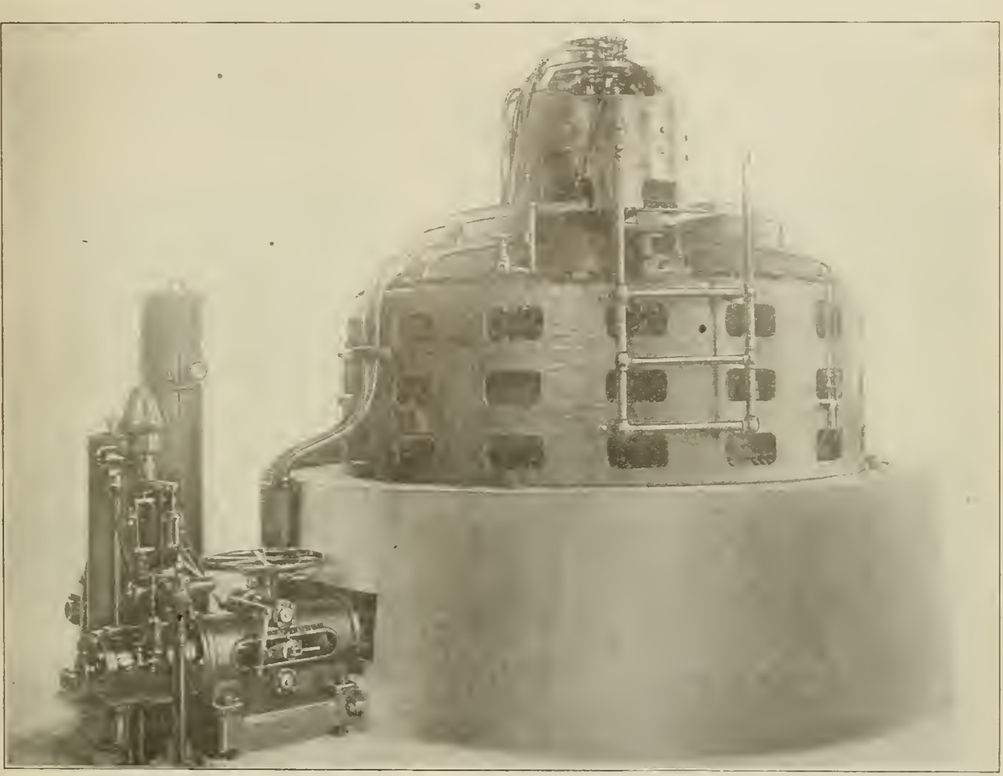


FIG. 5. HYDRAULIC TURBINE EQUIPPED WITH SPRING THRUST BEARING

Coal Prices and Coal Profits

THE diagram, Fig. 1, is reproduced from the United States Geological Survey Bulletin, "Prices of Coal and Coke 1913-1918," by C. E. Lesher. The explanation accompanying it is as follows:

1, 2. The downward trend of the price of bituminous coal in 1913, 1914 and 1915 is shown by both the spot prices and the average prices realized. From a general average spot price of $1.47 in January, 1913 (1), prices declined tc $1.14 in July, 1915 (2).

3. The strength of the demand in the winter of 1915-1916, particularly manifested in the Eastern States, is indicated in the rise in the general average spot price to $1.54 (3).

4. The highest point reached by the general average spot price was $3.77 in June, 1917 (4).

5. The amount of reduction effected by the Peabody prices is well illustrated by the drop in the curves from (4) to (5).

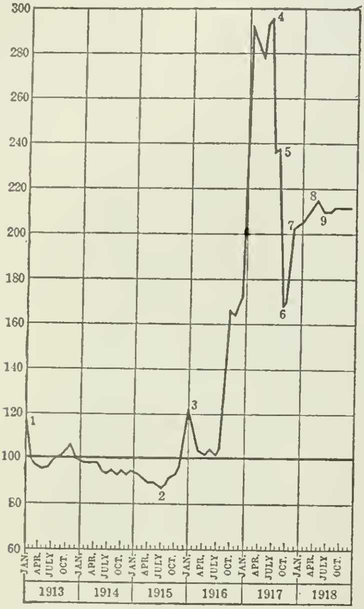


FIG. 1. RELATIVE SPOT PRICES OF ALL BITUMINOUS COAL PRODUCED IN THE UNITED STATES, 1913-18

6. Likewise, the further decrease in the general level of prices brought about by the President's price of Aug. 21, 1917, is shown by the drop in the curves from (5) to (6).

7. The general effect of prices of bituminous coal of the wage advance in November, 1917, is indicated by the rise from (6) to (7).

8. Advances in price in various fields authorized by the Fuel Administrator, as the result of the investigations of the cost of mining, raised the general level gradually to a maximum under Government control in May, 1918 (8).

9. The general reduction in price of 10 cents a ton on all bituminous coal ordered May 25, 1918, is reflected in the curves at (9).

The tables and their respective diagrams are reproduced from the Coal Report of the Federal Trades Commission for Pennsylvania Bituminous. Table I shows the distribution from time to time between the items of labor supplies and general expense and margin to operator of each dollar paid by the purchaser for coal to the operator for the central field in Pennsylvania. Chart 13 shows these facts in graphic form. Table II shows the same facts for varying periods and by the calendar years 1916-17-18, and is the basis of Chart 14.

It will be noticed that the part of the amount paid by the purchaser, which went to labor, varied greatly. It was highest (66 per cent.) in 1919 and lowest (43 per cent.) during the period April-August, 1917, following the expiration of the 1916 contracts and just preceding the establishment of governmental regulation.

TABLE I. DISTRIBUTION OF THE AMOUNT PAID BY THE PURCHASER BETWEEN THE VARIOUS PRINCIPAL COSTS AND THE MARGINS, BASED ON EACH DOLLAR OF SALES REALIZATION, 1917-18, BY MONTHS.

Month	Labor, Cents	Supplies, Cents	General expense, Cents	Total f. o. b. mine, Cents	Margin Cents
1917					
January	51	8	16	75	25
February	49	7	16	72	28
March	48	7	15	70	30
April	44	7	14	65	35
May	43	9	12	64	36
June	42	8	11	61	39
July	43	9	11	63	37
August	44	10	12	66	34
September	45	9	13	67	33
October	46	9	13	68	32
November	52	9	11	72	28
December	54	9	14	77	23
1918					
January	55	8	11	74	26
February	52	8	11	71	29
March	49	8	10	67	33
April	51	9	11	71	29
May	52	10	11	73	27
June	53	8	11	72	28
July	54	9	11	74	26
August	54	9	10	73	27
September	57	10	11	78	22
October	58	11	11	80	20
November	60	13	13	86	14
December	62	13	14	89	11

for the last nine months of 1918 (April-December), when practically the entire output of the mine was subject to the price regulation of the Fuel Administration, the share of labor was 56 per cent. of the amount paid by the purchaser for coal.

It will also be noticed that the part of the amount paid which went to the operator—that is, the margin—varies greatly. It was lowest (6 per cent.) in 1916 and highest (36 per cent.) during the period April-August, 1917. It must not, however, be supposed that such margins were all clear profit to the operators. The Commission's "revised" cost figures exclude any charge for interest, income and excess-profits taxes, donations, etc., which are expenses which, while not entering into operating cost, must be met from the margin; nor is there any allowance in the total f.o.b. mine cost for the expense of selling the coal.

TABLE II. DISTRIBUTION OF THE AMOUNT PAID BY THE PURCHASER BETWEEN THE VARIOUS PRINCIPAL COSTS AND THE MARGIN, BASED ON EACH DOLLAR OF SALES REALIZATION, 1916-1918, BY VARYING PERIODS AND BY CALENDAR YEARS.

Period	Labor, Cents	Supplies, Cents	General expense, Cents	Total f. o. b. mine, Cents	Margin Cents
Year 1916	66	7	21	94	6
January-March, 1917	50	7	15	72	28
April-August, 1917	43	9	12	64	36
September-October, 1917	46	9	13	68	32
November, 1917-March, 1918	52	8	12	72	28
April-December, 1918	56	10	11	77	23
Year 1916	66	7	21	94	6
Year 1917	46	9	13	68	32
Year 1918	55	9	11	75	25

Considering the total investment as the amount necessary to operate its business, whether in the form of capital stock and surplus, bonds or other borrowed money, the return on the total investment in the business, after deducting the estimated selling expense from the margin and before deducting interest on borrowed money or Federal income and excess-profits taxes, is shown in the following statement for the years 1916, 1917 and 1918:

	1916	1917	1918
Margin between f. o. b. mine cost and sales realization	$0.080	$0.920	$0.780
Estimated selling expense	0.015	0.015	0.015
Return on total investment, before deducting interest on borrowed money and Federal income and excess profits taxes	$0.065	$0.905	$0.765

The Trade Commission's Report says:

> In conclusion, the practical effect of governmental regulation of bituminous coal prices may be summarized as follows:
>
> In these two (the Southwest and the Central fields) Pennsylvania fields and for the country in general what governmental regulation of bituminous coal prices really did was—first, to check abnormal rise in prices, due to frantic bidding against each other by the consumers for an insufficient supply, and, second, to establish prices and maintain conditions which (after practically the entire output has come under regulation) allowed the operator margins materially lower than those prevailing for the preceding 12 months, though high enough to assure the increase in output which was vitally necessary to the successful prosecution of the war.
>
> Furthermore, in considering future policy the past experience of the bituminous-coal industry should be considered.
>
> It is highly desirable that definite up-to-date information be collected and made readily available for use. It is the opinion of the commission that the coal situation is so important and the knowledge of coal costs so essential to intelligent policy that some governmental body should be charged with the duty of regularly obtaining and promptly compiling current costs and average prices which would be available not only for the use of the Government, but also to all other interests involved—the operator, the miner, and the consumer.

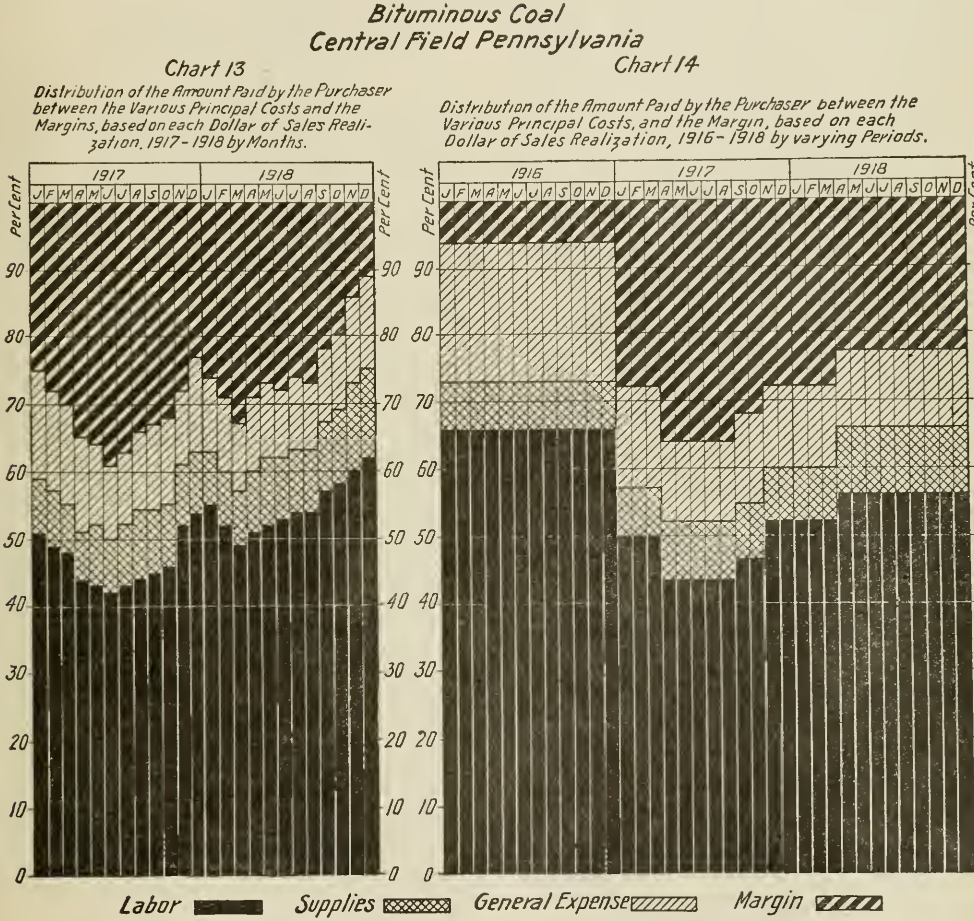


FIG. 2. DISTRIBUTION OF COSTS OF PENNSYLVANIA BITUMINOUS COAL.

Many attempts have been made to secure an insulating liquid which would not be combustible, and these attempts have mainly taken the form of the production of a material in which the hydrogen of the hydrocarbon has been replaced by chlorine or a similar substance. Tetrachloride of carbon is satisfactory from some standpoints as an insulating liquid to replace transformer oil, but on account of the low temperature at which it boils, and on account of the physiological effect of the vapor on operatives, it has never made much headway as transformer insulation. Its production would make a notable advance in transformer engineering.

Rules for Boiler Inspection

By C. A. Allison

The following instructions are for the annual external and internal inspection of certain types of water-tube boilers:

Stop delivering coal to the boiler furnace that is going to be taken out of service.

Burn out the fire in the furnace as quickly as possible and close the damper. When the fire is out, close the boiler stop valve and notice if the auto-stop valve is tight.

Blow all water out of the boiler when the steam is down to 15 pounds.

Blow and clean off all soot from the tubes, superheater and headers.

Take off all handhole plates on the front header and manhole plates on the back of the steam drums. Inspect for leaky handhole plates on the back header; if any are found, remove them and put on new gaskets. All handhole plates on the back header are to be taken off and cleaned every two years.

Inspect the tubes inside the furnace for bags and blisters. If defective tubes are found, cut them out and replace by new ones; mark them when they are inspected.

Inspect all tubes internally for mud or scale. If scale is found, remove the handhole plates on mud drum and use a mechanical cleaner to remove the scale from the tubes.

Inspect the steam drums and water columns, and if scale or mud are found, wash out, clean and scrape.

Inspect the superheater and its connections to the steam drums, also inspect the baffle plates of the feed-water distributor and the dry-pipe for the outlet of steam.

After the scale or mud is removed from the steam drum, inspect the rivets and seams for corrosion, pitting or grooving of the steam-drum plates.

Inspect and clean the side walls, back walls and arches and back connections. If any defective brick are noticed, have them renewed or repaired.

Inspect the stoker and furnace grates; if defective, repair or renew defective parts.

Take down the steam gage and have it tested to read correctly; mark the date of the test on the gage.

Open the air vent on the steam drum and fill the boiler with water, taking notice while the boiler is being filled of any leaks and marking them.

After the boiler is filled with water up to the top of the steam drum, close the air-vent valve, and raise the water pressure to 100 lb. Then inspect the boiler for any leakage. If there is any leak that cannot be stopped while under a water pressure of 100 lb., remove the pressure and blow down the water so as to be able to stop the leak.

After attending to the leak, put the boiler under water pressure again at, say, 100 lb. for a start, inspect the boiler and if tight at that pressure raise the pressure to 200 lb. so as to be sure that the boiler is tight.

If the boiler is found to be water-tight under 200 lb. pressure, open the blowdown valve and remove the pressure from the boiler, open the vent valve on top of the drum and blow down the water until it shows one gage in the gage glass.

When the work herein outlined is completed, the watch engineer or boiler-room engineer is to inspect all apparatus and see that it is ready for service.

If everything is found to be in proper condition, close all doors, fill the stoker hopper with coal and start a slow fire.

When steam begins to blow from the vent pipe on top of steam drum, close the vent valve and allow the pressure to rise to 20 lb. When this pressure is obtained, blow out all water from the superheater, close the superheater valve and allow the pressure to rise slowly not to exceed 50 lb. per hour and allow the pressure to rise to within 5 lb. of the working pressure. When this pressure is obtained, open up the boiler stop-valve and connect the steam main and the boiler together.

After the boiler stop valve is opened up, the boiler is ready for service, and a regular fire is to be maintained in the furnace. The task of external and internal inspection is now completed.

Some Pointers on Flumes

By L. W. Wyss

There are natural soil or rock flumes which convey water to the intake racks and spillways of hydro-electric developments. The various artificial flumes can be classified as follows: Soil; soil with timber cribbing; soil with rock ripraping; soil with concrete lining or reinforcing; rock; rock with concrete lining or reinforcing; wood; and steel. Wood and steel flumes are sometimes supported by trestles and they are sometimes carried over valleys or streams on bridges.

Attention should be given to soil flumes to prevent cave-ins or washouts, which may slowly fill the flume or wash down the banks until considerable work is necessary in order to insure against complete destruction.

A growth of vegetation such as grass, clover or willows will help to retain the original embankment. Where small streams flow into soil flumes, they often carry considerable soil into the flume or wash the flume banks. This can be avoided by deflecting the small stream or arranging to carry the water to the flume in a trough or pipe.

At one place where an earth flume is in use, a soil diversion dam 10 ft. high and 280 ft. long was built about a quarter of a mile from the flume, and a hill was cut through in order to deflect a stream of water that flowed only in rainy weather.

Rock and concrete flumes require little or no attention, but it may be well to remember that where water pockets exist and are exposed to freezing temperatures, deterioration may result. Wooden flumes are, of course, preserved best when the wood is completely saturated.

Steel or iron flumes should not be allowed to rust until considerable scraping is necessary to remove the rust, as it is more economical to paint them often. Metal that is always submerged does not corrode so fast as that submerged only part of the time. Where flumes are supported by trestles, the foundation should be watched carefully, as settling might cause a leak that would undermine the flume and cause serious trouble.

There are, of course, many hydro-electric developments that are without flumes, having the intake screens and spillways located adjoining the reservoir. At such places little trouble is encountered with ice or river trash at the intake racks, because the velocity of the water is not great enough to prevent bypassing the trash with booms through trash gates. Also, in the winter time the low velocity prevents needle and anchor ice from forming before the river freezes, and this in turn prevents any floating trash from reaching the intake screens.

EDITORIALS

Unconscionable Profits

THE prosecution of Western oil producers on charges of profiteering has been ordered by Attorney General Palmer. Senator Capper says that they have increased their prices from about a dollar a barrel before the strike to four dollars and a half a barrel.

William G. McAdoo, former Secretary of the United States Treasury, says that in 1917 the mine owners made "shocking and undefensible profits" on bituminous coal. He saw their income and excess-profit tax returns. They showed earnings on capital stock, he says, ranging from fifteen to two thousand per cent. Earnings of from one hundred to three hundred per cent. were not uncommon.

The bituminous coal operators admit that profits were abnormal in 1917; but claim that the Government promptly put an end to them. How abnormal they were and how promptly the Government put an end to them is shown in the tables and charts reproduced from bulletins issued by the Geological Survey and the Federal Trade Commission on other pages of this issue.

Harry A. Garfield, Federal Fuel Administrator, says that the average realization upon 579,385,820 tons of bituminous coal mined in 1918 was $2.61 per ton; that the average cost of production during the same period was $2.15 per ton; that the margin of 46 cents per ton does not include interest charges, selling expense, Federal taxes, etc. The average income and excess-profit taxes for 1918 were upward of 30 cents per ton.

Hon. Carter Glass, Secretary of the Treasury, says:

> Coal operators generally in the United States in the years 1914 and 1915 lost money when normal depletion and depreciation are taken into consideration. What is meant by this is that a proper item in fixing costs is depreciation of plant and depletion of the cost or value of the coal in the ground.
>
> In the latter part of 1916 all coal companies in the United States, save those in the extreme West, began making money, with the result that the operations for the year 1916 generally show a profit of from 10 to 35 per cent. on capital invested.
>
> In 1917 all bituminous coal mines east of the Mississippi River made what might be termed fabulous profits, the general average being from 100 to 150 per cent. on invested capital, the range being from 15 to 800 per cent.
>
> In 1918 conditions were not so good in the Appalachian and central competitive districts, profits generally being reduced 25 to 30 per cent. less than for the preceding year, the range being from 15 to 300 per cent. on invested capital. In the West conditions in 1918 were better than in 1917, the profits in the Rocky Mountain Districts ranging as high as 400 per cent. on invested capital.
>
> Unofficial figures for 1919, incomplete of course, indicate the profits of the operators are less than for 1918, some of the operators claiming to have actually lost money.

J. D. A. Morrow, vice president of the National Coal Association, says that for the entire bituminous industry to make profits of from 100 to 150 per cent. would require a total profit of upward of $1,500,000,000. According to the United States Geological Survey Report, "Coal in 1917," he says that the total gross receipts of the operators for all the bituminous coal produced in 1917 was only $1,249,272,837. Hence he says the total gross receipts, before deducting operating expenses, were less than the alleged profits.

The total number of tons of bituminous coal mined in 1917 was 551,790,000. If the foregoing statement of gross receipts is true, the average selling price must have been $2.26 per ton.

The operators say that they will welcome the publication of "just as full current tax returns for the bituminous-coal industry as are published from any other industry," and Mr. Morrow requests Mr. Glass to "also publish for other industries their average percentage of profits both before and after Federal taxes have been paid."

District representatives of the United States Government filed in the Federal Court at Pittsburgh on December 8 a suit against the Transcontinental Oil Company, of that city, in which it is claimed that the concern had charged unjust and unreasonable prices for fuel oil. The allegation is made that the officials named sold fifteen thousand barrels of fuel oil for three dollars a barrel. Several other sales are cited.

Attorney General A. Mitchell Palmer says that up to the end of October, 1919, there had been ninety-two cases of seizure for profiteering in foodstuffs. In addition twenty-two instances of alleged hoarding have been reported and instructions issued to seize the goods and prosecute the offenders if the facts warrant such action. Approximately 4,800,000 dozen eggs, 1,700,000 pounds of butter, 2,500,000 pounds of meat and 20,000 cases of canned goods were included in these seizures.

Bradstreet's "index number" of commodity prices on December first sets the highest average prices yet recorded, and now stands at 131 per cent. above prewar levels.

The readers of *Power* are the largest purchasers of fuel. They are entitled to know the cost of its production and how that cost is made up: How much they are paying for the coal in the ground (the depletion charge) and how much the producers paid for it; how much profit it represents; how much they are paying the miners—for it is they who, ultimately, pay the miners' wages; how much interest they are paying on money actually invested, and what becomes of the difference between less than $2.50 per ton at the mines and the price at which coal is landed at the average power plant.

They are willing to pay a fair wage and a fair return to capital and enterprise, but no "unconscionable profits." Let us have the facts.

Accuracy at the Switchboard

TOO much stress cannot be laid on the necessity of accuracy at the switchboard in accomplishing successful, safe, efficient power-plant operation. Switchboard instruments, such as the synchronoscope, power-factor meter, wattmeter, ammeter, voltmeter, etc., are types of apparatus that are comparatively simple when understood in theory and operation, but may be so governed by conditions not immediately apparent as to confuse one who is not familiar with the instruments. The indications of such devices cannot always be taken at their face value; some thought must be given to all the conditions surrounding them and their connections and operation. There is a tendency among many operators to familiarize themselves only with the purpose of the apparatus under their care, without interesting themselves in the theory of operation or the manner in which the various devices function; so that when some unusual or complex condition arises, for which a previous knowledge of their equipment would have prepared them, they misread the circumstances and commit some blunder.

Electrical machinery is no longer the "mystery" that it was some years ago, nor is the operation of it today the hit-and-miss process of old. Numberless books and papers are immediately available upon the appearance of each new device, and thereafter are continually added to. The operator of any device has the advantage over the designer of the equipment, in being able to continuously observe its operation; and the competent operator is the one who carries in his head, or at least in his notebook, every essential detail of all the apparatus in his care.

Beauty of design in the modern switchboard is not intended to be at the expense of utility. Such a simple device as the pilot light, with its shining gooseneck and green lampshade, may give a finished appearance to the switchboard; but the expense of its installation has not been fully justified if the location of the potential transformer, the primary and secondary fuses, and all the devices in the pilot-light circuit are not the intimate knowledge of the operator of that switchboard. The ammeter is intended to register the ampere load on the main circuit; yet the ammeter is only a part of an auxiliary circuit formed by the secondary winding of the current transformer, the current coils of the wattmeter and power-factor meter, and the circuit-breaker relay; furthermore, the position of the needle on the ammeter scale may not always be an exact indication of the ampere load on the main circuit. The capacity of a machine or cable, the setting of a circuit-breaker, the exact location and connections in the circuit of a potential or current transformer, or a control fuse, or synchronizing receptable—all these are details that many an operator has had cause to regret that he did not know.

Do Not Forget The Young Fellow

TOO often one is likely to forget that the engineers of tomorrow are the young firemen, cleaners and oilers of today. We do not want to preach a sermon; but we do not hesitate to remind our older readers, those in charge or in a position to help others, that it is just as truly their duty to give a lift to the progressive young men under them as it is to discharge their routine obligations.

Colleges may turn out a finished student, but none makes a pretense of furnishing the world with finished workers. To the young man who is not fortunate enough to have received a college education the places in which he is employed, if they are in his chosen field, are his school and his coworkers his teachers. To some few selfish, hairbrained individuals such ambitious young men are a joke and a nuisance, something to be fired out and replaced by the mediocre youth who will regard them as boss—and god. There are few such narrow men, but one finds one now and then. To the studious young man who has to tolerate such, we say get out; get away quickly though you have to owe a week's board to do so.

When one talks with men who have been successful, who have not hesitated to assist younger men to rise, he learns that the act of helping others is not only one of that man's great gratifications, but the spirit was one of the vital factors responsible for his own success.

There are many ways to help the young fellow who deserves it. Among the best is to promote him when he merits it and opportunity allows. This means that he should have the chance of familiarizing himself with the duties of the job higher up. In one of the most successfully conducted power plants—the Holtwood Station of the Pennsylvania Water and Power Co.—employees are required to know such duties as well as their own.

One of the fundamentals in the defunct Institute of Operating Engineers was that the power plants of its member engineers-in-charge should be schools for the younger men in so far as it was practicable. This plan is just as good as it ever was, whatever faults the Institute may have had—if, indeed, it had any. To adopt it in a plant might require procedure different from that necessary to successfully supply it in another; but it is one sound way of helping the progressive young man.

National Board of Boiler and Pressure-Vessel Inspectors

IN DISCUSSING matters pertaining to boiler legislation, *Power* has frequently voiced the opinion that there should be organized, as soon as a sufficient number of the states had established boiler-inspection departments, a national association of boiler inspectors, at which methods of inspection, the interpretation of rulings, the approval of specific designs and the respects in which experience shows revision of existing codes to be necessary could be discussed. Such an association was organized in New York on December second. Its membership is restricted to inspectors or other officials charged with the enforcement of regulations covering boilers and pressure vessels in cities and states which have adopted the American Society of Mechanical Engineers' Boiler Code. John F. Scott, of New Jersey, was elected chairman; James Neil, of Pennsylvania, vice chairman, and C. O. Myers, of Ohio, secretary-treasurer.

This society has a real mission, and as state after state realizes the importance of boiler legislation, and establishes boiler-inspection departments, we shall see it grow into a great national institution, whose task it shall be to reduce the industrial casualties from boilers and other pressure vessels to something like the proportions which exist in countries which have for years insisted upon a system of inspection which assures safe design, construction and operation.

The High Cost of Striking

W. D. McKINNEY, secretary of the Southern Ohio Coal Exchange, estimates that the loss to the United States on account of the recent coal strike amounted to about $126,000,000, of which about $60,000,000 consisted in loss of wages to miners and $40,000,000 of loss to railroads. Losses to industries shut down on account of fuel shortage are not included, and are not determinable, and so everybody is the poorer.

The La Salle is the only hotel in Chicago, if not in the country, that has lowered instead of raised its prices. This is the house in which the engineer, W. W. Bird, saved forty-five thousand dollars a year by reorganizing the power plant. They evidently have efficient heads of other departments.

CORRESPONDENCE

Sodium Bichromate in the Refrigerating System

In the Aug. 12 issue of *Power*, W. T. Meinzer states that in June, 1918, the United States Food Administration recommended the addition of one-half pound of sodium bichromate to each 100 lb. of aqua ammonia in the charge of an absorption refrigerating machine to prevent the formation of foul gas in the system and the corrosion of the pipes and tanks in contact with the aqua ammonia. He states that he put about 30 lb. of this chemical into the system under his charge and found that it prevented to a great extent the formation of foul gas, but that he wished to see the subject discussed in *Power*. He further stated that when washing out the machines he found a considerable quantity of black deposit in the generators, and that a sample of it analyzed by a chemist showed it to contain a large percentage of iron oxide. Here he found it necessary to renew 125 disks of valves on the generators, weak-liquor coolers, exchangers and other parts of the machine in contact with the aqua ammonia, but no renewals were necessary where only gas came in contact with these parts.

I advise Mr. Meinzer not to put sodium bichromate in the ammonia system and to use nothing but genuine wrought-iron pipe wherever the ammonia comes in contact with the piping; to use nothing but the best grade of ammonia and be sure it *is* the best; to put a vacuum on the absorber only when it is necessary; to keep the aqua pump rod in good condition and well packed. He, of course, has in mind that good ammonia quite frequently passes to the atmosphere around the rod, and that foul gas, water and air get into the system around the same rod. If I were in his place, I should send the entire charge of ammonia back to the manufacturer and have it rectified.

I should fill the entire system with distilled water that had been reboiled, and to this water I should add ¼ lb. of boiler graphite for each ton of refrigerating capacity. The water then should be heated to 180 deg. F. and the aqua pump started to circulate the distilled water and graphite through the system for six or eight hours, keeping it at a temperature of 180 deg. I should then draw out the water and refill with fresh reboiled distilled water and circulate it in the same manner until the system was clean. After this a clean charge of ammonia should be put in. Plenty of both aqua and anhydrous ammonia should be kept in the system and aqua should be kept out of the evaporator. The aqua should never be allowed to get below the coils in the generator. The generator should be large enough to do the work with not more than 15 lb. steam pressure. High-pressure steam means high temperature, and high temperatures always make foul gases in the refrigerating system.

As for the use of caustic soda in lime to prevent corrosion, it is my opinion that if the air can be kept out of the brine it will not be necessary to use the caustic soda; but if air is allowed to be drawn in with the brine through faulty pumps or agitators, trouble is sure to follow.

Winkelman, Ariz. GEORGE J. TROSPER.

Water Column Blowoff Valves

In the issue of Sept. 23, page 518, Mr. Noble and Mr. Jackson comment on the subject of water column blowoff valves and seemingly favor Mr. Cultra's idea. I am, however, opposed to it because I have had a few experiences that justify me in my stand.

Some years ago I was employed as a fireman in a paper mill that had been built to run by water power, but on account of dry seasons and an old and leaky dam, the power was inadequate and a 100-hp. engine had been installed to help out. The superintendent looked after the engine during the day, and at night the fireman took a squint at it once in a while to see whether it was smoking from lack of oil.

We had a 4-in. steam line branching out from the main line and leading to the paper machine. One night the inlet valve to the line began to leak around the stem, and one of the helpers got a wrench and tried to tighten it up, but only succeeded in making a bad thing worse, as the packing gland came out and also the packing. He sent a hurry call to me to shut off the boilers from the main line. Instead of doing that, I went upstairs and closed the valve to the 4-in. line, after which it was an easy matter to repack the valve stem.

Mr. Jackson claims that he has not yet found a globe valve the stem of which he could not pack while under pressure regardless of whether the steam was above or below the valve disk. He must certainly be a wizard, and I would like to be told in what way I should have proceeded in the event that the 4-in. valve had been so placed that the steam came on top of the valve disk.

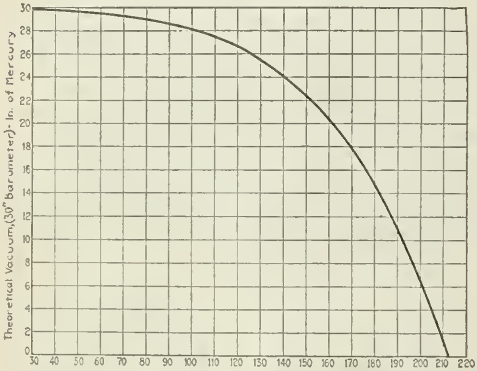
That a valve will close very tight with the pressure on top of the disk is true, as was proved to me very recently. We have a 160-hp. boiler, and in order to clean it it was necessary to have a small upright boiler to provide steam to run the pump that was used for flushing and also refilling the large boiler. On one occasion I had everything ready to start the pump and, as I thought, I opened the valve, but was surprised to find that with 60 lb. pressure no steam came through. Upon investigation it was found that the pressure was on top of the valve disk which had worked loose from the valve stem and was held firmly to its seat. That valve will never do that trick again. GUSTAV SWENSON.

Rockford, Ill.

Why Not Express Vacuum Values in Per Cent?

On page 396 of the Sept. 2 issue, Waldo Weaver advocates expressing vacuum-gage readings in per cent. of barometer readings. He very properly points out that the vacuum-gage reading means nothing, apart from the barometer reading, since the barometer varies widely at any one place, depending upon weather conditions; and under like conditions varies from place to place, depending upon altitude. Expressing vacuum as a per cent. of barometer is not, however, the logical solution of this difficulty. If it were possible for one to be inside the vacuum space of a condenser, he would be conscious only of the absolute pressure existing there. This pressure is fixed by the temperature of the cooling water, the amount of air leakage and the capacity of the vacuum pump. Outside atmospheric pressure has no influence whatever, except as it affects slightly the rate of air leakage. It seems unreasonable to express the record of pressure inside the condenser on the basis of atmospheric pressure, with which it is in no way connected.

The confusion so common in this connection arises from the available methods of measuring the pressure in a condenser or other vacuum apparatus. Such a pressure would be indicated directly by an ordinary barometer within the vacuum space, and there are on the market direct-reading absolute pressure gages based on this principle, but it is far more common to use a vacuum gage for this purpose. A vacuum gage, whether of the bourdon or mercury-column type, measures the *difference* between two pressures—the absolute condenser pressure and atmospheric pressure. Now the barometer reading is a measure of the absolute pressure of the atmosphere. Therefore, to get a true indication of conditions inside the condenser, we should subtract the vacuum-gage reading from the barometer, thus obtaining the absolute pressure within the condenser. The atmospheric pressure enters the problem, not because it has any logical or physical connection with the matter, but merely because it is a convenient datum from which to measure with simple instruments. Since it is itself variable, it must be eliminated by expressing the result in terms of absolute pressure. Doing this with Mr. Weaver's values and adding a column of absolute pressures to his table, we have the accompanying table. It is clear from this table that a given per cent. vacuum, as figured by Mr. Weaver, does not always correspond to the same absolute pressure.



CURVE SHOWING RELATION BETWEEN WATER TEMPERATURE AND THEORETICAL VACUUM

VACUUM EXPRESSED IN PER CENT.
Average Values in Everyday Operation

Locality	Weather	Barometer, In. Hg.	Vacuum, In. Hg.	Vacuum, Per Cent.	Absolute Pressure. In. Hg.
New Haven Conn...	Fair	30.0	28.0	93.3	2.0
	Stormy	29.6	27.6	93.2	2.0
Dayton, Ohio........	Clear	30.4	29.4	96.7	1.0
	Fair	29.3	27.4	93.5	1.9
	Stormy	28.9	27.4	94.8	1.5
Akron, Ohio........	Clear	29.7	28.6	96.3	1.1
	Fair	29.1	27.2	93.5	1.9
	Stormy	28.7	26.8	93.4	1.9
Kansas City, Mo....	Clear	29.4	27.4	93.2	2.0
	Fair	28.7	26.8	93.4	1.9
	Stormy	28.3	26.4	93.3	1.9
	Clear	29.1	27.2	93.5	1.9

Suppose we consider a condenser having a fixed absolute pressure, while atmospheric pressure rises. If the barometer rises by one inch the vacuum gage also rises one inch, the absolute pressure remaining the same. To express this constant absolute pressure as a percentage of the varibale atmospheric pressure, to which it is in no way related, is no better than using the vacuum-gage reading directly. The case is much the same as though a man on an elevator were to measure the elevation of another elevator at lower level in an adjoining shaft. By dropping a tape to the lower car, he could determine the difference in level (the vacuum). This alone is useless, but if at the same time he notes the elevation of his own car above the bottom of the shaft (the barometer), subtraction gives him the elevation of the lower car (the absolute condenser pressure). To express the elevation of the lower elevator as a per cent. of that of the upper would give no definite idea of the location of either.

There is a method of expressing vacuum in per cent., which is used in connection with data concerning water-jet vacuum pumps. In such a pump the theoretically possible absolute pressure is limited by the temperature of the water supplied to the pump. Reducing this absolute pressure to vacuum referred to a 30-in. barometer (or to any other desired value) gives the theoretical attainable vacuum. Actual vacuum readings, referred to the same barometer reading, are expressed as a per cent. of this theoretical vacuum. The relation between the water temperature and the theoretical vacuum is shown by the accompanying curve. With an actual vacuum of 28 in., with water at 70 deg. F., we should have 95.7 per cent. of theoretical vacuum. With water at 90 deg., the very same vacuum would be 98.0 per cent. of the theoretical maximum. This method of expressing vacuum in per cent. of the theoretical maximum has some justification, since the theoretical maximum represents a real physical fact in the operation of water-jet vacuum pumps. It should be noted, however, that the per cent. of theoretical vacuum means nothing apart from the water temperature.

Indeed, vacuum alone, no matter how it may be expressed, requires other information to give it significance. If engineers would talk and think in terms of absolute pressure only, there could be no doubt of what is meant. C. HAROLD BERRY.

Detroit, Mich.

In answer to Waldo Weaver's letter in the Sept. 2 issue, I think that there are at least two better ways to express vacuum, or pressure below atmospheric, than in per cent.: (1) Inches mercury absolute pressure; (2) inches vacuum at 30 in. barometer.

For quite a number of years I have handled correspondence in which vacuum is an important factor

This experience has led to the conclusion that one of the expressions cited, preferably the former, or its equivalent, is by far the most satisfactory and explicit way of expressing a vacuum condition.

Mr. Weaver is right in saying that "inches vacuum" is meaningless. An inquiry was once referred to me as to why only 20 in. vacuum could be carried in a machine which was designed and sold for operation at 28 in. vacuum (at 30 in. barometer). A little investigation showed that the machine was installed at an elevation at which the normal barometer is 22 in. and was, of course, operating at 2 in. mercury absolute pressure, as intended.

The expression "per cent. vacuum" has the same uncertainty, to a less degree, as "inches vacuum," but the possible error might still be serious. For instance, in the case cited, "90 per cent. vacuum" would mean to me at sea-level 27 in. vacuum at 30 in. barometer, or 3 in. absolute pressure, while the customer might have used 90 per cent. vacuum to mean $0.9 \times 22 = 19.80$ in. vacuum at 22 in. mercury, or 2.2 in. absolute pressure. The difference in the economy of the machine under the two conditions would be quite marked, and guarantees made under such a misunderstanding might cause the unnecessary loss of an order.

Expressions (1) and (2) are not so brief and easy to say as "inches vacuum" or "per cent. vacuum," but they have the infinite advantage, from an engineering point of view, of being exact and unmistakable—in a word, foolproof. My experience has taught me that it does not pay to use abbreviated expressions, as the slight saving of time or space is frequently offset many times over by the bother of straightening out a misunderstanding. It should always be remembered, particularly in engineering matters, that a certain combination of words may convey somewhat different thoughts to different people; therefore, the simplest statement can hardly be made too clear. It is often advisable to express the same thought in two different ways, as this method usually leaves no reasonable possibility of misunderstanding, even though either expression may be imperfect. For example, "28 in. vacuum or 2 in. absolute" leaves no doubt that the condition expressed is the same as 2 in. of mercury absolute pressure.

It is not my purpose to discuss here the effect of vacuum on the economy of the steam turbine, but Mr. Weaver's remarks on the subject impel me to say that his conclusions are contrary to my experience. Tests taken under my observation, by as exact methods as could be devised, show that a properly designed turbine will have its water rate decreased several per cent. for each inch of vacuum up to about 29½ in. at 30 in. barometer.
E. C. Perry.

Lynn, Mass.

Would You Raise Your Pay If You Were Your Boss?

You know the fallacy of perpetual motion. You can't logically expect to get more out of a thing than you put into it. With 100 per cent. efficiency you can get out exactly what you put in, but no more. If one actually gets more than one is worth someone else is suffering for it and is getting less than he is worth.

Face the facts. How much revenue are you really producing for your employer? Are you turning out all the results possible in your working hours?

Some day just keep track of where the time goes. Divide the time into five-minute periods and make a note of when you start each piece of work and when you finish it.

Be honest about it. If you waste five minutes talking to the man across the way, put it down. If you lose fifteen minutes idly day-dreaming, while pretending to be engaged in deep thought, put it down, for this is to be a strictly intimate personal affair, and when it is completed you are likely to want to burn it up so that no one else will see it.

You will be surprised to see how much time has slipped through your fingers—time, the thing that once wasted can never be brought back.

After a while you will be able to judge yourself and your boss more accurately. You can then answer the question, "If I were my boss would I give myself a generous raise?"
S. F. Wilson.

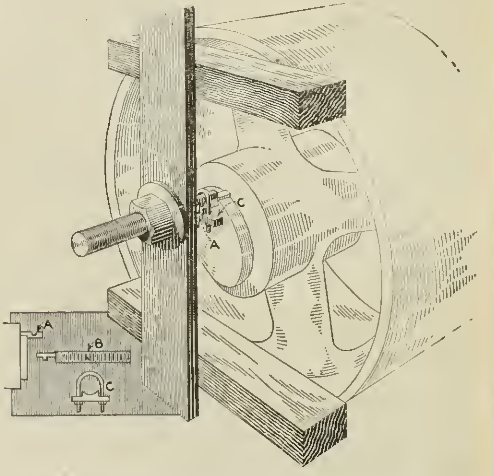
New York City.

Removing Heads from Motor Pulley

When it is necessary to remove a motor pulley it is frequently a difficult job to get the key out. The way some keys are driven it would appear that it was never intended that they should be removed. In taking off a motor pulley that resisted the usual methods, the following scheme was used:

The pulley was keyed to the armature shaft with a headless key extending about an inch from the end of the shaft. The original key must have become loose, allowing the pulley to work off, but whoever put this one in intended it to stay there, as it showed all the signs of having been driven home for keeps. With a hacksaw blade bent inside the pulley, a rough notch was cut in the key about ¼ in. from the end, as at *A*. Then a ⅝-in. bolt was ground and filed flat at the head end, leaving a projection to fit the notch in the key, as at *B*. By using an ordinary cable clamp, shown at *C*, borrowed from the elevator operating cable, the bolt and key were clamped securely together. A piece of flat iron with a hole bored in it for the bolt was placed over the end of the pulley on wooden blocks, as shown in the figure. A nut was then screwed down on the bolt against the iron, and in this way the key was easily removed, after which the pulley was taken off without difficulty.
H. Wilson

Toronto, Ont., Canada.



KEY-PULLING DEVICE; PARTS AND ASSEMBLY

Boiler-Tube Failures

I read with interest the letter by Waldo Weaver on "Boiler-Tube Failures," page 887 of the June 10 issue of *Power*, also the later articles on the same subject. There are many good points in these articles, and I believe a discussion of the advantages and disadvantages of the different methods of scale removal and prevention will be of interest and value.

Mr. Applebaum, page 477, of the Sept. 16 issue, seems to be partial toward lime-water softeners. While this is one of the logical methods of keeping boilers clean, the first cost of such equipment has proved prohibitive in the majority of average-sized plants. In some cases water softeners cannot be used, or when used are only from 50 to 75 per cent. efficient, as in some waters the scale-forming matter can be precipitated only by being subjected to very high temperatures. Therefore most water softeners would be of little or no use where such conditions prevail.

Warren D. Lewis, in the same issue, favors the graphite treatment. "The doses to feed boilers advocated by manufacturers of this product are intended to get the scale out of a boiler in 'jig' time, and they usually do," he says. This statement called to mind an experience while visiting a certain city recently. In passing the plant of a manufacturer of graphite, my attention was arrested and my curiosity aroused by hearing the unmistakable sound of a boiler-tube turbine cutting through hard scale. As the window was open in the boiler room, I looked in and, as I expected, saw a man turbining a water-tube boiler.

In view of the foregoing, I would like to ask Mr. Lewis if, as he states, graphite will remove scale in "jig" time, why is it necessary for the manufacturer of this product to turbine his own boilers?

Although I do not agree that graphite is a scale remover, it has been my experience that coating the inner surfaces of tubes and headers with a thin coat of graphite is good practice. This can be done with a swab attached to the end of a length of ⅜- or ½-in. pipe. I have found this practice, when applied to clean boilers, to delay considerably the formation of scale. But in time it will be found that the graphite so applied will be washed off by the action of the water, leaving the surfaces bare; then any new scale-forming matter coming in contact with these surfaces, will bake on, forming scale. In my opinion, based on close observation in practice, after the scale has started to form no amount of graphite introduced with the feed water will remove the scale already in the boiler or prevent the majority of new scale from forming.

I believe that (disregarding water-softening systems that remove most of the impurities from the water outside of the boiler, as most engineers must disregard them as unattainable), the logical way to keep boilers clean is to use some form of mechanical treatment that will precipitate all scale-forming matter in the form of sludge. Then, if the boilers are blown down at regular intervals, the surfaces can be kept clean without difficulty.

I do not favor the chemical treatment of water inside of the boiler by means of present-day compound, as I do not think the amount of compound recommended is strong enough to treat the large volume of water. To a 100-hp. boiler operating ten hours per day, for instance, it is usually recommended that one gallon, or less, of compound be used. Let us assume one gallon of compound weighs ten pounds. A 100-hp. boiler will evaporate 3750 lb. of water, from and at 212 deg. per hour, or 37,500 lb. of water for a ten-hour run. According to this it will be necessary to feed one ounce of compound to each 6000 lb. of water. In other words, this would amount to a $\frac{1}{96,000}$ solution, which is very weak.

The foregoing theory, of course, has been expounded before, among other manufactures of a few boiler treatments that are claimed to prevent the formation of scale by coating the inside of the boiler. This coating, being smooth, is supposed to prevent the adherence of scale-forming matter.

Now the question arises, What is to prevent the latter-mentioned treatment from forming so thickly that it would retard the transmission of heat to such an extent that it would be as bad as a coating of scale? Even though it is a conductor of heat, as is claimed, this is possible. Boiler iron is as much a conductor of heat, I believe, still it has been ascertained that 10 in. of boiler iron, 1 in. of scale or $\frac{1}{10}$ in. of oil offers equal resistance to the transmission of heat. Would it then become necessary to turbine the boilers to remove the excess material? Or would it be possible to remove it by turbining?

All engineers are agreed on one point, however—that to maintain the highest efficiency it is necessary to keep all boiler surfaces clean. They differ only in the means of attaining that end.

I recently had occasion to investigate the claims of a manufacturer, of a process designed to keep the boiler surfaces clean without turbining by precipitating the scale-forming matter in the form of sludge. This process is purely mechanical in its action. The preparation used is composed principally of aluminum oxide and aluminum phosphate, the soda content being but 1.09 per cent. The aluminum oxide and phosphate being insoluble in either hot or cold water, are kept in constant agitation inside the boiler by the circulation of the water. These particles in constant agitation come in contact with the minute particles of scale-forming matter as soon as such matter starts to adhere to the boiler metal, wiping the particles off and precipitating them in the form of sludge. For oil this material seems to have an affinity, as it absorbs or unites with it, causing it to settle in the mud-drum, from which it can readily be removed by the regular use of the blowoff valves.

With this method of treatment it can be readily seen that no variation in the chemical composition of the feed water can affect the results.

Brooklyn, N. Y. EUGENE TOUSSAINT, JR.

Brasses Improperly Fitted

I had trouble with an engine some years ago as follows:

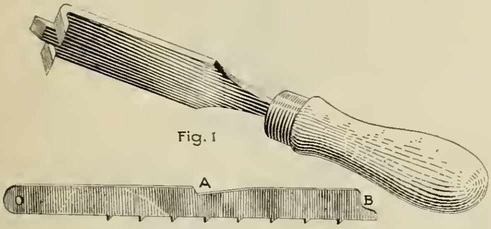
The wristpin bearing would wear so fast that it had to be taken up about three times a week. After carefully fitting the brasses to the pin and determining that the valves were properly set, I still had the same trouble, but one day while holding my hand on the head-end brass I found it to be slightly loose and working in the strap, owing to an improper fit. After this was properly fitted, there was no further trouble with the engine.

White Plains, N. Y. JOHN W. HILFRANK.

Removing Retaining Wedges and Coils from Induction Motors

In the Aug. 12 issue of *Power,* W. J. Hohe asked for some suggestions on how to remove retaining wedges and coils from induction motors. The operation is usually attended with some little difficulty and requires considerable skill and patience at times, in order to prevent damage to the windings.

Metal or fiber retaining wedges can generally be knocked out easily enough by means of a steel drift having a blunt nose. Tapping the surface of the wedge sharply with a hammer and fiber drift helps to loosen and makes the wedge drive easier. The same method is applicable to wooden wedges, but is not always successful, as a very tight wedge will spread at the end or perhaps split. A driving tool fashioned from an old 12-in. hacksaw blade, Fig. 2, will be found useful in obstinate cases. Grind off most of the teeth, leaving about eight toward one end, about one-half inch apart. Striking an oblique blow at *A* and *B* forces the teeth into the wedge and provides a larger area of contact for the purpose of driving out. When it is necessary to cut out a wedge, the tool shown in Fig. 1 will be found useful. It can be made from an old flat file or wood chisel. The shoulders rest on the top of the slot and when held at the proper angle the tool will cut the center of the wedge out, without cutting through into the coil; the remaining pieces may then be picked out.



FIGS. 1 AND 2. TOOLS FOR REMOVING RETAINING WEDGES FROM STATOR SLOTS

In order to replace the damaged coils of an armature or stator, it is necessary to raise one side of the coils which overlap the one to be removed. With the open-slot type of winding the first coil is the hardest to lift without damage to the insulation. A good method for a tight job is as follows:

Take two pieces of strong, thin leather about eighteen inches long and one inch wide (heavy duck cloth, doubled and stitched will do) and rub them with soapstone or wax. Separate the coil to be raised from the others by means of small wooden wedges. Place the tape through the coil at the end of the winding and work it up to the end of the slot. A strong pull will then generally do the trick. With this coil up, the tapes are more easily applied. Lifting tools as described on page 467 of the Sept. 16 issue can also be used to advantage. The frame should be heated if the insulating cells stick to the sides of the slots.

The semi-closed slot machine is more difficult to handle, and when the impregnating varnish or compound has lost its life and become hard and brittle owing to overheating, it is practically impossible to raise the wires out of the slots without peeling the insulation. In such a case it is advisable to rewind the whole machine.

Where there is only one coil in each slot, an emergency repair may be made by pulling in one or more coils without raising the span. When the compound is in good condition, heat applied to the frame, either in an oven or by current from a suitable low-voltage transformer, will tend to prevent the insulation peeling. To remove a coil strip or cut the covering tape to well behind the turn of the coil, loosen the wires outside the slot with a sharp fiber wedge and lift out one at a time. Try to prevent kinks and arrange the wires symmetrically so that they may be replaced in approximately the original position. Without care in this respect, it may be difficult to get all the wires back into the slot without abuse.

H. WILSON.

Toronto, Ont., Canada.

Why the Arrow on Belting?

In the Sept. 16 issue of *Power,* page 473, a correspondent asking Why the Arrow on Belting? has analyzed a belt problem under traditional installations, methods of care and treatment. If the salient features of the drive are as correctly analyzed as in the article in question and a belt selected to meet the requirements of the drive, there need be no allowance made for slip with subsequent proper care and treatment, unless there is a sudden great increase of load or frequent starting of loaded machines.

Under these conditions slip is expected to relieve a danger, which is one of the many good features of belt transmission. Under normal conditions slip and creep should not exceed 2 per cent. A larger average loss than this indicates a wrong that can and should be corrected.

Manufacturers of good leather belting, knowing these facts, place the arrow on the belt to indicate the direction in which the belt should run to give the greatest service—which is the measure of the belt's value.

Slipping belts and tight belts steal power, waste time, give inefficient service and are never far from the scrap heap.

J. FRED ENGLER.

Tyrone, Penn.

Frost on Compressor Suction Line

In the Aug. 12 issue, under "Inquiries of General Interest," was an item on the frosting back of the suction pipe to the ammonia compressor. The advantage gained by having frost on the suction pipe back to the compressor is that the lower the temperature of the gas the less volume it requires in the compressor per pound; consequently, the compressor can run slower for a given capacity. The frost on the suction line indicates that the gas passing through it is 32 deg. F. or lower. To operate a compressor efficiently, the suction gas should be as nearly saturated as possible. But to prevent the gas from becoming supersaturated, four or five degrees superheat should be carried. With a suction pressure of 15½ lb. gage the temperature of the ammonia is zero degrees F., and it should enter the compressor at this temperature plus this four or five degrees superheat; but it should never be above 10 deg. F. on entering the compressor on 15½ lb. pressure.

The greater density of the compressor suction gas is not the only advantage of having a frosted suction line. There are many. However, a frosted suction line is not by any means an efficient one, although a suction line heavily covered with frost is an indication of good operation.

GEORGE J. TROSPER.

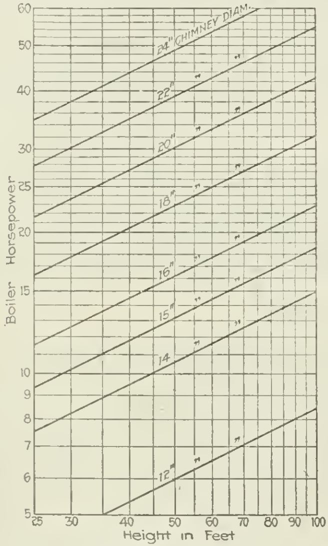
Winkelman, Ariz.

Chimney Capacities for Small Boilers

Some years ago *Power* published a chart by W. L. Durand from which could be determined the capacity of any chimney from 50 to 400 ft. in height and from 15 in. to 102 in. in diameter. The capacities ranged from 20 to 2000 hp. While the field covered by that chart included practically every necessity of the small and medium-sized power plant, it was hardly useful for the small heating installation.

The accompanying chart is also plotted on logarithmic paper from the Kent formula $Hp. = 3.33\,(A - 0.06\sqrt{A})\,\sqrt{H}$ and determines the capacity of chimneys from 25 to 100 ft. in height and from 12 in. to 24 in. in diameter. The capacities range from 5 to 60 hp. In Kent's formula, A is the area of the chimney in square feet and H is the height in feet.

In using this chart it should be remembered that cast-iron boilers are generally overrated, and therefore the size of the stack should be determined from the number of square feet of direct radiation actually installed. For example, a building requiring 2000 sq. ft. of direct radiation to maintain an inside temperature of 70 deg. would require a cast-iron boiler rated at 3000 to 3200 sq. ft. As a square foot of direct radiation normally condenses ¼ lb. of steam per hour, theoretically 138 sq. ft. is equivalent to one horsepower. In practice it is usual to assume 100 sq. ft. as equivalent to one horsepower, which allows for losses in piping, etc. It is important to note that this applies only to *normal* conditions. If direct-indirect or indirect radiation is used, it must be resolved into equivalent direct radiation. Moreover, unusual conditions of temperature must be taken into consideration.



CHIMNEY CAPACITY FOR SMALL BOILERS

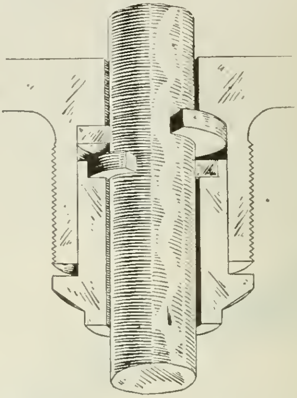
This chart can also be used on a hot-water job by multiplying the number of square feet by the B.t.u. emitted per square foot per hour and dividing by 33,482—the result being the horsepower. For normal conditions 75 per cent. of the total hot-water radiation will be the equivalent steam radiation, and the latter divided by 100 will give the horsepower.

New York City. HENRY P. KAHN.

Worn Plungers Caused Packing Trouble

A second-hand vertical four-plunger single-acting pump, installed to furnish 3000 lb. hydraulic pressure in a clay-working plant, gave an extraordinary amount of packing and valve trouble.

The plungers had to be packed three or four times a day as the packing would get chewed up, pull out through the stuffing-box glands, work back around the plunger into the pump chamber, and get under the valves and hold them off the seats enough to allow them to begin grooving. Then there was nothing but to shut down, repack plungers and regrind valves.



BUSHED STUFFING BOX AND GLAND

It was determined that the plungers, being badly worn, were the cause of the trouble, and new ones were ordered from the pump manufacturers. It would be some time, however, before the order could be filled, and in order to keep going without the annoyance and expense of continually repacking, the tool-steel plungers were taken out and turned down until straight.

This made the plungers considerably smaller than the holes in the stuffing-box gland and the bottom of the stuffing-box. In order to overcome this difficulty, brass rings were turned to a close fit for the bottom of the stuffing-boxes and bored a close fit on the new size of the plungers. A similar ring was made to go on top of the packing, but it was found that it was hard to remove when repacking, so it was removed and the old glands were taken out and bored for about five-eighths of an inch in the bottom and a brass ring driven in. In this way the top ring always came out with the gland. With these repairs, as shown in the illustration, the pump was run successfully until the new plungers arrived.

Cherryvale, Kan. EARL PAGETT

Maple Charcoal Not Good Filtering Medium

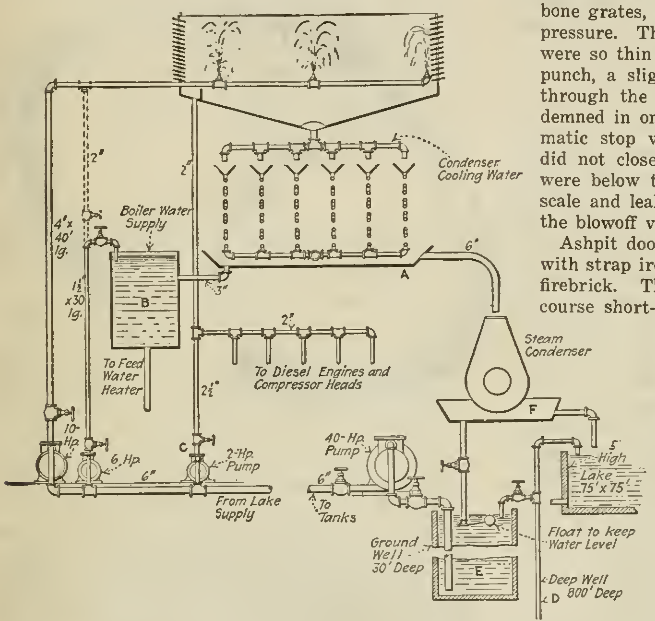
Some years ago on putting in service an ice plant located near New Orleans and using distilled water, we had considerable trouble with black specks in the ice. Mississippi River water was used and filtered through maple charcoal. In the midst of our troubles a fireman from a neighboring plant came in and, after inquiry, advised us that the charcoal was the cause. A change to bone was made, and the specks no more appeared.

San Francisco, Calif. O. JASON

Changed Ammonia Condenser Piping

When a plant has been gradually enlarged, first by one engineer and then by another, the probabilities are that changes can be made that will effect a saving in operation. The original cooling-water piping of a certain plant is shown by the continuous lines in the accompanying illustration. The changes and extensions made are shown by the dotted lines.

The pipe-line connection between the ammonia condenser pan *A* and the boiler feed-water tank *B* enables the cutting out of a steam-driven pump, making a considerable saving in steam. The water from the condenser is also warmer than the lake water, and owing to a water-heating system much of the water scale is left at the condensers instead of in the boilers. The steam pump is now held in reserve to pump water to the condenser coil in case the main pump fails. By extending the cooling-water system to the roof sprays, cooling water to the different unit heads is supplied from above also, thereby discontinuing the use of the 2-hp. electric-driven centrifugal pump *C*.



ORIGINAL AND CHANGED COOLING-WATER PIPING

Originally, the water was lifted from the deep-well supply *D* into the ground well *E*, and from there it was lifted by a 6-in. centrifugal pump to two railroad water tanks. By piping direct from the deep well into the lake, the cool water from the well could then be used over the condensers. Also, by connecting the steam condenser pan *F* to the ground well *E*, a considerable amount of hot water was taken out of the system and pumped to the railroad tanks. This change lowered the discharge pressure of the refrigerating machines from 210 lb. to 190 lb. The cooler water also condensed more exhaust steam, thereby saving a small amount of live steam. Then by installing a float-valve on the discharged end of the pipe from the steam condenser a constant water level is obtained in the ground well, which saved the extra average 15-ft. lift for the water pump to the railroad tanks.

The total cost of these four connections was approximately $60. The total estimated saving per month is $300. With the steam pump and small electrical centrifugal held in reserve, and the lake water to serve the railroads in case the deep well fails temporarily, the engineer in charge has a twofold safety factor, which means much in production. W. A. DARTER.

Brenham, Tex.

Mismanagement of Boilers

Of all the prizes ever drawn in power-plant management it is the belief of the writer that this is the star. I was instructed to inspect the boiler room of an Atlantic coast hotel which was commandeered for the purpose of remodeling it into a hospital for convalescing soldiers.

There were two Stirling boilers, hand-fired, herringbone grates, low setting, rated at 150 hp. at 150 lb. pressure. They were set in 1909. The boiler tubes were so thin in places that, when applying a center punch, a slight hammer blow sent the punch clean through the side of the tube; 54 tubes were condemned in one boiler and 29 in another. The automatic stop valves did not work because the disks did not close down on their seats. Blowoff valves were below the floor level in a pit, encrusted with scale and leaking. There was no plug-cock between the blowoff valve and the mud drum.

Ashpit doors were cracked and had been repaired with strap iron. Lost baffles had been replaced with firebrick. This baffling was not cemented and of course short-circuited the gases flowing around the baffling. The water columns were in a leaky condition, gage-glasses were milky with scale, gage-glass fittings were green from the chemical action of the scale and water, try-cocks were missing on one of the water columns and those on the water column of the second boiler were too full of scale to permit lifting by hand. Insulation on all piping had entirely disappeared. The glass faces of the steam gages were missing, and water leaking past the dials indicated the need of new gages.

The top of the windbox of the blower formed the bottom of the ashpit. This forced ashes over the front of the mud drum when the draft was on. Ash handling was difficult because the floor of the boiler room was four feet below the street surface. A water meter was set at the entrance of the boiler room between the boilers and the door. Thus ashes had to be handled twice.

The exhaust from the steam engine was piped inside of the chimney to the top instead of passing through the feed-water heater. The heater drew live steam from the boiler to heat the feed water. The water-pump follower rings were cracked and the piston scored, but it managed to feed "some" water to the boiler. Engine crosshead guides had to be rebabbitted as they had been running iron-to-iron. The top of the frame was cracked but had been oxyacetylene-welded. Both cylinder and piston were scored, the packing worn and loose, the Corliss gear out of alignment and knocking, and the valves were not set for proper lap and lead.

The separator insulation was missing and the drainage plugged. No trap had been provided to catch the drain from the separator.

Investigation of the water conditions disclosed the fact that at certain times salt marshes would overflow into the wells and no further attention was paid to this water as far as chemical analysis was concerned. The result is apparent. S. ROSENBERG.

New York City.

Repairs to a Steam Turbine Governor

The following account of an accident and repair to the governor of a steam turbine may be of interest to *Power* readers.

The machine is a Curtis Horizontal, 500-kw. 3600 r.p.m. In some manner, probably in stopping, one of the dogs controlling the opening of the steam valves became hooked up on the shield-plate cap and reciprocated the whole governing mechanism, all working with the steam arm. Later in the day, when the operator on watch went to put the unit in service, the accident was discovered. The dog was released and the machine tried again, but it refused to open the steam valves at all.

The first impression was that the spindle at the top of the governor had broken or become loose, and it was examined and found to be all right. Next, the plate on top of the governor weights was removed and the two transmission links taken out and examined, but they appeared all right excepting that the top bearing of one of them was badly worn. It was reasoned that this was hardly the cause of the trouble, for the wear had been six years taking place and the governor had been functioning perfectly. Nevertheless the hole was bushed, and a slight improvement was noticed, but still it was a long way from being in a satisfactory condition.

The operating crew was by this time "up a tree," the day being Sunday, and the unit had to be in service the following morning. The whole outside mechanism was gone over thoroughly, and nothing was found out of adjustment, broken or bent. The reciprocating of the governor parts, through the shield plate, governor connecting-rod and lever, to the links, put a severe strain on the links; as it was discovered, on trying with a bar, that it moved the governor weights out against the tension of the spring. At the same time there was nothing to show any derangement.

The transmission links are two small pieces of about ⅜-in. mild steel curved to a certain form, and it was decided they had straightened out under the strain referred to. They were taken out again and bent a little more, put back, and the machine given a trial. The improvement was enough to convince us that we were on the right track, so the turbine was stopped, the links again taken out and given a little more curvature. On another trial the valves all picked up on starting, and closed at the right time as the machine came up to speed, proving that we had located and removed the trouble.

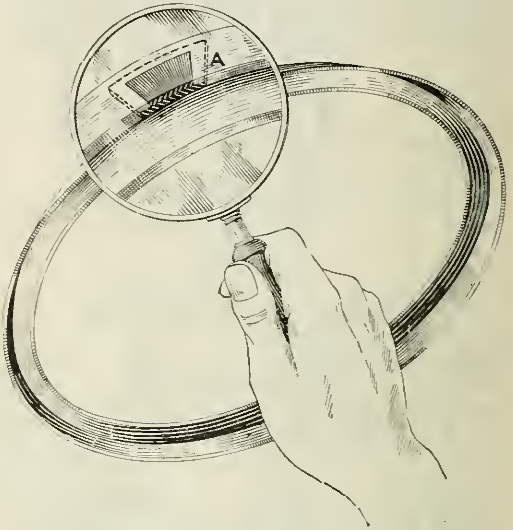
The puzzling feature of the case was that there was no indication as to what the trouble might be, as there was nothing apparently out of place. The remedy was arrived at by a process of elimination and deciding what was the weakest place that might give way under the excessive strain. J. A. WATKINS.

Jefferson City, Mo.

Repairing a Grounded Commutator

The method I used in repairing a grounded commutator may be of interest to *Power* readers. The ground was caused by the mica end ring breaking down on the outer end of the commutator. Before the commutator was opened for repairs, it was thoroughly cleaned with gasoline and an air blast. The commutator and shell were then heated so that the shell and the mica end ring could be removed without breaking the mica. As the coil leads were not removed from the bars, there was no need of clamping the commutator to prevent it from pulling apart. After removing the end ring, the inside of the commutator was thoroughly cleaned and painted with a commutator-insulating varnish. A new segment of sheet mica was cut to shape, using as a templet the old segment, which had been injured when the breakdown occurred. The inside edge of the mica alone was cut to size, the outer edge being left large, so that it could be turned off after assembling the commutator. The new mica segment was varnished on both sides and set in place. A patch was then put on the mica end ring by setting in two pieces of sheet mica 0.03 in. thick in such a manner that the joints were in no place nearer than ¼ inch, as shown at *A* in the figure. When reassembling the commutator, it was not necessary to give it a complete baking, as but a very small part of the mica was renewed. While hot the shell was drawn as tight as possible, and when the commutator had cooled it was turned and polished. A ground test with 1500 volts was made for one minute on the commutator without its showing any ill effects. R. L. HERVEY.

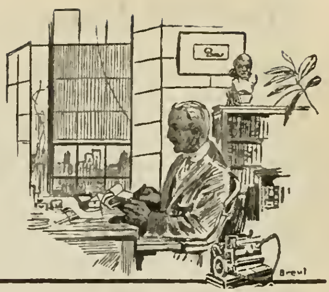
Washington, D. C.



MICA "V" RING SHOWING HOW THE REPAIR WAS MADE

The electric furnace used in the steel industry is of comparatively recent introduction. There are, however, over 800 of the furnaces in use at the present time, 300 of which are in the United States. The latter have all been installed during the last ten years.

INQUIRIES OF GENERAL INTEREST



Relative Cost of Water Supply by Air Lift—We have a well 700 ft. deep and, when previously used, the water supply was limited only by the capacity of the air-lift pumping equipment. Our boilers are operated at a cost of 32 cents per 1000 lb. of steam generated. Would it pay to resume operation of the air lift as against purchasing city water at a cost of 10 cents per 100 cubic feet? T. H.

An estimate of the probable efficiency of the air lift cannot be made without taking into account the depth of water standing in the well while pumping the required quantity of water, amount of submergence of the air pipe, the character of compressed-air equipment and amount of water required. With ordinary air-lift efficiency and neglecting extra labor and first cost under the conditions that are stated, the cost for operating an air lift should not exceed 75 per cent. of the cost for a city water supply.

Motor Overloads Generator—We have a 150-kw. direct-current 500-volt generator that supplies power to a 100-hp. motor. When the motor is started with no load, it takes from 240 to 260 amperes and causes the voltage to drop from 500 down to about 400. The starting box is rated at 100 hp., 500 volts and 160 amperes. I would like to know how to overcome the above trouble. J. F.

Where a 100-hp. motor is started from 150-kw. generator you may expect to have more or less trouble with voltage regulation. The current taken by the motor at starting is not excessive. However, since, as you state, the motor is started light, no doubt it can be started with the resistance increased about 100 per cent. in the starting box. This would reduce the starting current to about 120 or 130 amperes. If the motor is never started under full load, there is no doubt that a 50-hp. starting box would have sufficient capacity to take care of the motor, and this would cut the starting current in about half. You might make up a temporary resistance from some iron wire and connect it permanently in series with the armature lead with a single-pole switch, so that after the starting-box resistance has all been cut out the single-pole switch can be closed, and cut the temporary resistance out of circuit. Or you may make up a water rheostat and connect that in series with the armature circuit. On starting the motor, first bring the arm on the starting box over to the running position and then bring the electrodes together in the water rheostat. Of course the movable electrode of the water rheostat will have to be brought in contact with the solution before the starting-box arm is placed on the first contact or the motor will not start.

The poor voltage regulation experienced may be due to the governor on the engine being sluggish, or the series-field winding on the generator may be connected in opposition to the shunt-field windings. It would be advisable to make sure that the governor of the engine is in good working condition and then cross the series-field winding to see if this will give better voltage regulation. The regulation will either be materially improved or made worse; if the latter, put the connection back to the original arrangement.

Size of Delivery Pipe for High-Head Waterwheel—Where there is an ample supply of water, what size of pipe line 600 ft. long would be required for delivery of sufficient water to a turbine waterwheel under a gross head of 400 ft. for the development of 50 hp.? J. M.

Allowing 75 per cent. efficiency, "the power in the water" delivered at the waterwheel would need to be $50 \div 0.75 = 66\frac{2}{3}$ hp. or $66\frac{2}{3} \times 33{,}000 = 2{,}200{,}000$ ft.-lb. per min. Where $l =$ the loss of head in feet due to pipe line friction, $h = 400 - l =$ the net or effective head in feet of the water as used at the wheel, then the flow of water per minute would need to be $\frac{2{,}200{,}000}{h}$ lb.; or $\frac{2{,}200{,}000}{h \times 62.4} = \frac{35{,}256}{h}$ cu. ft., or $\frac{2{,}200{,}000}{h \times 7.48} = \frac{294{,}118}{h}$ gal. per min.

By referring to tables giving loss of head per 100 or per 1000 ft. length of pipe of various sizes for different rates of flow and bearing in mind that for a given size of pipe the loss of head from friction is directly as the length, assume different values for l and find the smallest pipe that will deliver $\frac{35{,}256}{h} = \frac{35{,}256}{400 - l}$ cu. ft. per min., or $\frac{294{,}118}{h} = \frac{294{,}118}{400 - l}$ gal. per min.

If 5 per cent. of the total head is lost in friction, then for $l = 600 \times 0.05 = 30$ ft., or $30 \times \frac{1000}{600} = 50$ ft. per 1000, the flow would need to be $\frac{294{,}118}{400 - 30} = 795$ gal. per min.

With a loss of 40 ft., or $40 \times \frac{1000}{600} = 66.6$ ft. per 1000 the flow would need to be $\frac{294{,}118}{400 - 40} = 817$ gal. per min., and with a loss of 50 ft., or $50 \times \frac{1000}{600} = 83.3$ ft. per 1000, the flow would need to be $\frac{294{,}118}{400 - 50} = 8.40$ gal. per min.

Referring to Weston's Tables of "Friction of Water in Cast-Iron Pipes" (which for all practical purposes may be assumed to be applicable to steel or wrought-iron pipes), it may be seen from the table that a 4-in. pipe would have insufficient capacity with any of the assumed losses of head. With a 6-in. pipe it may be seen that a discharge of 800 gal. per min. corresponds with a loss of 59.48 ft. of head and a discharge of 8.25 gal. per min. corresponds with a loss of 63.25 ft. of head, the average of these values giving 812.5 gal. per min. for 61.36 ft. per 1000, or $61.36 \times \frac{600}{100} = 36.8$ ft. loss for 600 ft. of 6-in. pipe.

Substituting 36.8 for l in the expression $\frac{294{,}118}{400 - l}$ shows that for 36.8 ft. loss of head, or $400 - 36.8 = 363.2$ net head, the demand would be $294{,}118 \div (400 - 36.8) = 810$ gal. per min., or less than 1 per cent. below the computed average discharge.

Fuel-Oil Papers at Philadelphia Engineers' Club

THE interest that fuel oil has created along the Atlantic Coast was well indicated Thursday evening, Dec. 11, when two papers were given on the subject at a combined meeting of the American Society of Mechanical Engineers and the American Society of Heating and Ventilating Engineers at the Engineers' Club, Philadelphia. Henry Thomas, combustion engineer, of the Sun Co., dealt with the production and commercial end, while E. H. Peabody, of the Babcock & Wilcox Co., New York, discussed the subject from the standpoint of the consumer. The hall, though not a large one, was so crowded that many of those in attendance sat in the aisle on the floor, and when this became full, the back of the hall was jammed with those who were standing.

MR. THOMAS' PAPER

Mr. Thomas began by dwelling upon the historical aspects of the subject, stating among other things that Pennsylvania rock oil was found in 1854 and that in 1859 the first oil well was drilled in Pennsylvania, yielding 25 bbl. a day and continuing in operation for one year. The yearly production in 1859 was about 2000 bbl. According to the Geological Survey, he said, the world's petroleum production for 1918 was 514,208,718 bbl. and the production for the United States was practically 355,000,000 bbl. Pennsylvania wells, he said, ranged in depth from 200 to 1000 ft., a few going considerably deeper; the Mid-Continent wells from 1500 to 1900 ft.; Gulf, from 800 to 900; California, 2000 to 5000 ft., and Mexican wells, from 1000 to 2500 ft. He then described the systems of drilling wells. Considerable gas pressure is invariably met with in wells, running from 800 to 1000 lb. per sq.in., which acts to gush the oil from the well. When sufficient gas pressure is lacking, the wells are frequently torpedoed to start the flow. The cost of drilling wells, he said, ran from $40,000 to $60,000, particularly in the Texas and California fields.

The Appalachian fields give oil which ranges from 40 to 48 deg. Baumé; Mid-Continent fields, 27 to 40 deg.; Gulf fields, 14 to 25 deg.; California fields, 12 to 30 deg., and the Mexican fields, 10 to 20 deg.

He said that about 150,000,000 bbl. of oil is used in the United States per year for fuel, including distillates.

Some of the large consumers of oil on the Pacific Coast, such as the Southern Pacific Co. and the Santa Fe R.R., are now using Mexican instead of California oil. The marine use of California oil is heavy. In 1918 Mexico produced 63,000,000 bbl. of oil, or about 15 per cent. of the world's supply, and in 1919 the production will be approximately 80,000,000 bbl.

The first well driven in Mexico was that by Doheny in 1901. The largest Mexican well gave 1,000,000 bbl. of oil per day for five days, but much of the oil was lost because inadequate storage facilities prevented saving all of the flow. One well, opened in 1914, gave at the beginning 264,000 bbl. per day. This well is still in operation, but at a reduced rate. The wells of Mexico, according to Mr. Thomas, now produce from 10,000 to 60,000 bbl. per day. In February, 1919, there were 299 wells producing oil in Mexico, and up to this time 500 had been abandoned since 1901.

The Tampico fields give oil that runs from 10 to 14 deg. Bé. and are responsible for about 30 per cent. of Mexico's production. The Tuxpam fields give oil from 10 to 19 deg. Bé. and are responsible for about 70 per cent. of the production. The Tuxpam oils contain 10 to 15 per cent. of the light distillates, which are driven off by distillation before the product is marketed as fuel oil. The Tampico oils, which are much heavier, are not generally topped. The topped fuel is, of course, cleaner and much safer. The flash point will run about 200 deg. F., and the heating value will average about 18,400 B.t.u., giving about 149,000 B.t.u. per gal.

While the present production of Mexican oil will run from 80 to 90 million barrels per year for 1919, the United States Geological Survey estimates that the potential capacity of Mexico is about 1,000,000 bbl. per day, while the Mexican Petroleum Commission estimates the capacity at 2,000,000 bbl. per day. About 175,000 bbl. per day is now taken from Mexican wells.

The various oil companies, said Mr. Thomas, are now ready to spend $100,000,000 in the further development of the oil business in Mexico.

About one-half of the vessels of the United States Shipping Board Emergency Fleet Corporation use oil, while the navies of the world are very heavy users of it.

As bearing on the coal and oil shortage, Mr. Thomas mentioned that England's export coal trade heretofore amounted to about 70,000,000 tons per year, whereas now it is down to 30,000,000 tons per year. Of the 326,000,000 bbl. of oil produced in 1916, about 75,000,000 was used for fuel purposes.

It is Mr. Thomas' opinion, based upon the figures available to him, that the Mexican oil supply will be equal to the demand at least for some time to come. The history of the oil business up to date has shown that there is a steady increase in production, but the demand has kept ahead of this. As illustrated why this demand comes about, he said that 6,000,000 automobiles required about 100,000,000 bbl. of gasoline per year in 1918.

Surveys seem to show, he said, that there are in the ground about 6,740,000,000 bbl. of oil. The shales of Colorado and other American states contain oil to the extent of about 25 gal. per ton of shale, and the deposits are capable of producing 75,000,000,000 bbl. The cost of producing oil from the shale, he said, ran from 1½c. to 2c. per gallon. Fifty per cent. of the oil resources in the shale is equal to 50 times the production of petroleum in 1914.

Mr. Thomas here enumerated several advantages of fuel oil over coal as a boiler fuel, but these are so widely known that they are not enumerated here.

One of the advantages that he gave was the "low cost of equipment for the burning of the oil." It is to be regretted that there was not more discussion of this phase of the subject, as it is of vital concern, particularly to the large user, and is one of the two vital factors that convince one that one ought to make the change or discourage one from further considering the change.

Speaking of the storage capacity that a plant ought to have, he said that this would, of course, vary with local conditions, but it should be one week's supply at least, some plants requiring a month's supply. He deems it advisable to use two storage tanks so that one may be available for use while the other is being cleaned or subject to repair. Up to 100,000 gal. the horizontal tank, about three feet underground, is most desirable. For greater capacities the vertical steel tank above ground is preferable.

Speaking of the mechanical burner, he said that it used oil at about 200 deg. F. under high pressure at the burner. The maximum theoretical CO_2 content of anthracite coal will run about 19.2 per cent., that of bituminous coal 18 per cent., and that of fuel oil 14.5 per cent. Oil, said Mr. Thomas, is a zone proposition on account of the transportation difficulties.

At this point Dean J. K. Allen, Chief of the Research Bureau of the American Society of Heating and Ventilating Engineers, which is operated in conjunction with the United States Bureau of Mines at Pittsburgh, Penn., injected considerable humor into the meeting and also told of the work of the Research Bureau. "The essence of practice is research," said Dean Allen. He was interested in "utilitarian research, which applies not only to the engineer, but to the community."

MR. PEABODY PRESENTS THE CONSUMER'S POINT OF VIEW

The chairman then introduced E. H. Peabody, who made it plain that he could express the subject only from the consumer's point of view by giving his point of view of the consumer's point of view. In the combustion of oil, he said, the greatest problem is the reduction of excess air. "The oil supply appears not to be sufficient to meet our needs." The two questions which confront the consumer and which are of vital importance are: Can oil be obtained in necessary quantities and with necessary regularity? What will it cost compared with coal? As to labor saving, the advantages are all with oil. This is true even in the production, for it requires considerably less labor to produce a given heat value in oil than with coal and the consumption requires far less labor. No generalities can be made to cover all plants as every plant presents a peculiar problem of its own. As to the relative cost of coal and oil, Walter M. McFarland, of the Babcock & Wilcox Co., has deduced a simple relationship in the cost of producing steam by oil and coal. In round numbers a pound of oil is equal to a pound and a half of coal, or approximately one ton of coal is equal to four and a half barrels of oil. Oil at two cents a gallon equals coal at four dollars a long ton. This ratio will hold for oil prices; the quality of coal, is of course, assumed to be fairly high, having a heating value of approximately 14,300 B.t.u. per pound.

It is not so much the burner that is of importance in an oil-burning plant as it is the furnace and the methods of admitting and controlling the air for combustion. The choice of burners, said Mr. Peabody, invariably reduces itself to the mechanical design of the burner as it permits of ease of repair, removal and replacement.

There are, so far as the speaker could determine, no advantages in any system that attempts first to gasify the oil completely before its combustion in the boiler burner. This has been tried but the developments have now ceased.

The history of oil burning in this country began in 1901 with the discovery of the Texas gusher, Spindle Top, and continued for some little time until oil became so valuable for refining that further developments in its combustion in furnaces was stopped. It had not occurred to the speaker that Doheny's Mexican well had been discovered in the same year that Spindle Top had been discovered. Speaking of the advantages of the outside over the inside mixing burner, Mr. Peabody claimed that experience had shown that there was really no advantage possessed by the inside mixer, but rather that the advantages lay with the outside mixer. This is because atomization cannot take place inside a mixing chamber, but must take place at the orifice of the burner. Schutte's mechanical burner was the first to be brought out in the United States, and the development of this burner was soon added to by Mr. Koerting. In 1907 the United States Navy Department experimented very widely with the mechanical burner, and it is, in part at least, because they confined their experiments chiefly to the mechanical burner that this type is found universally aboard ship. At any rate, said Mr. Peabody, it is to be regretted that the Liquid Fuel Board did not more widely consider steam atomization.

In modern naval practice the boilers aboard destroyers have from 11 to 16 burners per boiler. The flat spray has distinct advantages in many cases, said Mr. Peabody, and he and his associates have tried to develop a mechanical burner that would give a flat spray, but so far have not produced one that was as successful as desirable.

THE VISCOMETER HAS NOT BEEN STANDARDIZED

Speaking of the viscometer, Mr. Peabody expressed deep regret that this had not been standardized, particularly in America. The Engler instrument is widely used on the Continent, and also in this country. As a matter of fact, said Mr. Peabody, "I do not recall what viscosity in terms of the Saybolt instrument is." He tried to secure tables giving the comparison of the standard Saybolt, Redwood and Engler viscometers, but while a few comparative figures of this kind are published, as for example in the United States Navy Oil Specifications and also in Redwood's "Treatise on Petroleum," he was told that no tables had been made for the reason that the relationship of the three scales differs with different characters of oil. This is but one of the added complications in the present practice of measuring viscosity.

In view of the fact that until recently it has been the practice of the petroleum companies to recommend that the temperature of the oil delivered to the steam-atomized sprayer be kept at about 145 deg. F., it was of interest to hear Mr. Peabody say that he has never heard of any trouble by heating oil above its flash point, within reason. Of course if there are bad leaks, these leaks will be in some degree worse than they would be if the oil were not heated so high, on account of the gas that may leak through. In line with what Mr. Peabody says, it is generally known that experience, particularly in New England, is showing that excellent results are had where the temperature of the oil at the burner is kept at about 165 deg. F.

Mr. Peabody here went into a description of several types of air registers for mechanical burners and said that nobody can tell just what will be the action of a register, inasmuch as they are indeed very capricious.

"There are no advantages in burning oil and coal at the same time," said the speaker.

It was of interest to hear him say that the mechanical atomizer has an assured field for land service. The advantage lies in the fact that the fireman has little or nothing to do with the amount of steam that may be required to burn the oil. With steam atomization, he said, there is absolutely no limit to the amount of oil a man may waste. With a coal fire one can only abuse it about so much and then the fire will go out, but with oil there is practically no limit, other than the capacity of the burner to flow oil, to which the oil may be wasted.

At this point Mr. Peabody gave some figures from the oil tests recently conducted by the United States Navy at the League Island Navy Yard, with the new type three-drum marine B. & W. water-tube boiler. In these tests astonishingly marked progress was made in the ability of the burners to burn oil at high rates of capacity. When one realizes that in 1907 from 400 to 500 lb. per burner was the limit, one gets an idea of the progress that has been made in but a few years. In one test a combined efficiency of 83 per cent. was had 1⅓ lb. of oil per square foot of heating surface was burned, 15 lb. of water per square foot of heating surface per hour was evaporated. In the test where 83 per cent. efficiency was had, the rating was 150 per cent, 1½ lb. of oil per square foot of heating surface was burned and 22¾ lb. of water per square foot of heating surface was the evaporation rate. *Power* hopes to be able to obtain these test results from the Navy Department at an early date.

DISCUSSION OF PAPERS

Charles Bigelow, in answer to a question, received the reply that some gasolines were available in America from the Mexican oils.

Horace P. Liversidge, assistant chief engineer, Philadelphia Electric Co., was of the opinion that small plants having a load factor of 35 per cent. presented an entirely different problem from the cost standpoint from plants having a higher load factor, say 50 to 60 per cent. and above; he believes that the plant with the lower load factor, say 60 per cent. down, might find it economical to use oil, but that the plant with a higher load factor would not. He said that the supply of coal is quite stabilized as compared with the supply of oil. There are two classes of installation—one where coal is already in use when a change to oil is contemplated, and the other a new plant where the initial installation may be for coal or oil. Each class presents a different problem in the matter of cost, particularly investment cost, and their influence upon the question of whether it would be worth while to change from coal to oil. In answering, Mr. Peabody said that he did not regard the question of load factor as a serious one, but thought that in either direction above or below 60 per cent load factor oil should show an advantage over coal from a combustion-cost standpoint. The matter of investment necessary for the changeover was, of course, an important one.

Mr. German, of Waterbury, Conn., in answer to an inquiry, was told that a steam atomizer uses about 1½ to 2 per cent of the steam generated by the boiler for use in atomizing and that the mechanical burner requires a small amount in addition.

Mr. Lewis, of the Buffalo Forge Co., in answer to an inquiry, was told that the oil-burner designers do not figure on injection action to induce air for combustion.

W. J. Pollack, of the Badenhausen Co., asked if stokers should be removed or left in when the change is made from coal to oil. Mr. Peabody was of the opinion that the stokers should be removed except that he called attention to the fact that there were settings that had the oil burners located at one end of the boiler and the stoker installation at the other, thus requiring no withdrawal of the stokers in the event of using the oil equipment.

Mr. Windell called attention to the atomization of oil by centrifugal force by means of a cuff, or disk rotated by a motor; this type of burner one will recognize immediately as the Fess, particularly adapted to small installations. Mr. Peabody believes there is a large field for this kind of burner.

C. H. Bromley, associate editor of *Power,* called attention to the lack of available data on the cost of concrete fuel-oil storage tanks and of the actual cost of changing over from coal to oil as compared with the estimated cost. Experience shows, he said, that the actual costs are considerably in excess of the estimated costs. Many at the meeting wanted cost data, but were up to date unable to obtain any that they could talk about. Mr. Bromley asked if Mr. McFarland's figures as to relative costs of performance with coal and oil, namely two-cent oil being equivalent to four-dollar coal, considered the fact that oil lends itself far more readily to complete and perfect combustion than does coal. It would not be fair to oil, he said, to base any comparative figures as to performance to be expected solely upon the relative heat values of the two fuels. In answer, Mr. Peabody said that Mr. McFarland had taken into consideration in this rough "measuring stick," as he likes to call it, the superiority of oil over coal in actual combustion.

Mr. Bromley said that experience had shown that a greater combustion volume is needed for oil, particularly at high combustion rates, than is required with bituminous coals if not of a too long flaming nature. He asked what Mr. Peabody considered should be the relation between coal and oil as referred to combustion rates and combustion volume. Mr. Peabody said that the less the volume of combustion space provided per burner, the less the ultimate capacity per burner in pounds of oil burned under fixed conditions of draft.

Excerpts from Elevator Regulations

By EDWARD A. SMITH

Mechanical Engineer, Otis Elevator Co., New York, N. Y.

EXCERPTS from the elevator regulations of the building code of Chicago, Ill., as amended June 25, 1917. For power-driven passenger, freight and sidewalk elevators. Parts of equipment not referred to in the excerpts have no regulations.

Load: Passenger, Freight and Sidewalk—No regulation. Hospitals—Three stories or over must have platform having inside dimensions, 5 x 7 ft. minimum.

Run-by at Top: Passenger and Freight—Four feet between crosshead and underside of grating.

Pit: Passenger, Freight and Sidewalk—Two feet between bottom of car and bottom of pit; car at lowest landing.

Safeties and Governor: Passenger and Freight—Existing and future installations must have safety device and speed governor as required by commissioner of buildings. No governor required on freight elevator used in tunnels for freight service only. No safeties required on building hoists for material only.

Car Enclosure and Platform: Passenger—Enclosure on sides and top. No gate required. Car to be lighted. No freight compartment permitted. Freight—Enclosure or guard 6 ft. high; solid over counterweight. No top or gate required. Car to be lighted.

Control: Passenger, Freight and Sidewalk—Switch, hand-rope, push-button, wheel or lever permitted but not specified.

Ropes: Passenger and Freight—Two ropes required to car and each counterweight. One full turn on drum when car is at limit of travel. Machine-counterweight ropes which pass through car counterweight to be covered to prevent chafing. Sidewalk—Ropes or chains permitted.

Grating: Passenger and Freight—Grating of steel or heavy wire mesh to sustain 500 lb. Under sheaves or machine at top of shaft.

Counterweights: Passenger and Freight—Parts strongly bolted together.

Stop Motions and Shaft Limits: Passenger and Freight—Drum machines to have stop-motion device on machine, not operated by link belt or sprocket chains. Shaft limits for traction machines. No link belt or sprocket chain permitted between controller and operating device. Sidewalk—Machine limits or stop balls on rope or chain.

Emergency Switches: Passenger—Emergency switch in car for switch-controlled electric elevators.

Brakes: Passenger—Electric brake on switch-controlled elevator.

Hatchway Enclosures: Passenger—Future nonfireproof building shafts to be enclosed in brick, tile or other material approved by commissioner, to extend from foundation to roof. Fireproof shaft not required if building is equipped with complete sprinkler system. Existing and future shafts that extend to lowest floor must have brick, tile or other fireproof enclosure with fireproof doors. If shaft does not extend to basement, must have fireproof pits with openings only for ropes and machinery. If hatch is not enclosed in fireproof material, shaft must have enclosure of wire guard 6 ft. high. Full height over counterweight with wire guard or other fireproof material. Underside of all sills or projections in hatchway to be beveled with smooth steel 60 deg. with horizontal. Penthouses in buildings more than 50 ft. high must be of fireproof material. Roofs may be of mill-type construction or slow-burning material. Hospitals three stories or over to have fireproof shaft. Future shafts in hotels, clubs, offices, lodging houses (twenty or more persons) to be fireproof with fireproof doors. Freight—Same as passenger except existing freight elevators need not have enclosing walls but must have trap doors, with fusible links, which will close automatically when temperature exceeds 140 deg. F. provided building is equipped with passenger elevators, fire-escapes and stairs; otherwise, elevators must have fireproof enclosures.

Hatchway Doors: Passenger and Freight—Future and existing fireproof doors which open from outside only with a key or other device approved by commissioner, must be furnished with fireproof shafts.

Trapdoors: Passenger—Not permitted. Freight—On existing shafts not required to be enclosed (see shafts) must be self-closing with fusible links which operate at a temperature of 140 deg. F.

Dumbwaiters: In nonfireproof building hereafter erected, shafts to be enclosed in brick, tile, reinforced concrete or cement plaster not less than 2 in. thick or metal studs and lath. No other regulation.

Filing: Before starting work permit must be obtained from commissioner of buildings, specifying number and kind of elevators to be erected or nature of alterations, giving location of building; plans and specifications to be filed showing construction and type of elevator and location. Commissioner will issue permit; fee of $2 for each elevator or alteration. Permit required for installing iron doors or wirework enclosures, $2 for each elevator.

Operator: Operators for passenger elevators must close all doors before starting car and must not open doors before elevator is stopped. Fine for violation, $25 to $100.

Hydraulic Tanks, Valves and Cylinders: No regulations except tanks on roofs over 400 gallons must rest on solid brick or stone masonry or girders on masonry or iron or steel construction. Plans to be approved by commissioner and permit issued; fee $5.

Installations Prohibited: Hand-power to power-driven without first making application to commissioner. Also to connect electric motor or other appliance to hand-power elevator without a permit.

Repairs and Alterations: To conform to rules for new installations.

Tests: New elevators to be inspected and safeties tested and certificate issued and posted in cars before same are put in operation. Existing elevators to be inspected every six months; fee, $2.

Factors of Safety for Construction: Maximum fiber stress that steel is to be subjected to, 16,000 lb.; cast steel, 16,000 lb.; and wrought iron, 12,000 pounds.

Industrial Economics

Phases of the above subject were up for discussion at a joint meeting of the Chicago sections of the American Institute of Electrical Engineers, American Society of Mechanical Engineers and the Illuminating Engineering Society, and the electrical section of the Western Society of Engineers, held in the rooms of the society last named on Nov. 24. Harold Almert was chairman of the committee on arrangements and presided at the meeting.

Edwin D. Tillson, testing engineer for the Commonwealth Edison Co., spoke on the topic "Reaction of Labor to Intensive Lighting" showing in the course of his paper the effect of more intensive lighting on production. The Illuminating Engineering Society for several years had been conducting a campaign to bring about a revolution in factory lighting, not only in the intensity of light used, but in the location of units and in distribution. By means of lantern slides the speaker summarized the numerous business reasons for intensive lighting, and gave results of tests to show the increase of production by good illumination. The old standard of 4 foot-candles, was not sufficient. The Edison Company was advising 12 foot-candles, and there were numerous factories that had used higher intensities with good results. The illumination on various machines was pictured with lighting of 4 and 12 foot-candles intensity, and the effect were of single, double and triple shadows were made evident. To visualize the difference in lighting intensity a factory model was used to advantage, and an instructive comparison made between drop cord lighting and intensities of 4 and 12 foot-candles. In each case the location of the machine was varied, and comment made on the intensity of light on the various working parts.

In the speaker's opinion intensive lighting offered a great opportunity for conservation. The increase in production much more than offset the cost of current. As one of the factors influencing production it should be given serious attention by the engineer, and his active support would be appreciated by the Illuminating Engineering Society which had spent years in advancing the cause.

George H. Jones, power engineer of the Commonwealth Edison Co., showed how electrical power from central stations was an important factor in affecting economies and increasing production. With electric drive the power may be applied in the most direct manner, eliminating shafting, belt or rope drive and the accompanying friction. In the generation and distribution of electrical energy; not only coal, but capital and material as well were conserved by the economy of the central station. The large and efficient machines now used are much more economical than the small units in private plants, and due to the better load factor of the central station there is greater use of capital invested. In the central station itself, there has been great improvement in economy. The old figure of 7 lb. of coal per kilowatt-hour had been gradually reduced to 2.2 lb. per kilowatt-hour, the steam rate now credited to the large turbine units. The latter figure was compared to similar data from isolated plants both condensing and non-condensing. Coal consumption running as high as 12 lb. per kilowatt-hour for a condensing plant, and still higher for a non-condensing plant, was cited by Mr. Jones, the plants apparently being especially selected to make the case as strong as possible for the central station.

Reference was made to the saving of 13,000 tons of coal by 10 relatively small plants in Chicago, which had adopted the plan of taking Edison current during the summer, and operating their own plants throughout the heating season. The speaker remarked on the growth of the central station and the reduction in rates for service, the price being even a trifle lower than in 1914, although every other commodity had gone upward. Larger units, more efficient production, and a better and more diversified load factor had made this possible.

Harold Almert talked breifly on the personal efficiency of the employee. Due to the unprecedented return of our foreign born to their respective countries, and the slowing up of immigration, the man power of the country had been reduced considerably, so that it was more important than ever to utilize labor to the best advantage. How to improve the productivity of labor was a leading question. The mental attitude had changed remarkably since the war. There was no longer the desire to serve, nor the desire for efficiency for its own sake. The employer was held at arms' length, while maximum wages were demanded for a minimum of work. To compete for trade in foreign countries, commodity prices must come down, and to this end increased production was essential.

To bring this about there must be improvement of methods and machinery, and labor must turn about face and do a day's work. Statistics showed that production per man ranged from one-quarter to one-half of what it was in 1914. These facts must be brought home to the conservative element, so that they may again assume leadership. With the parasites and radicals who now rule labor, improvement could not be expected. Psychology must be applied to the problem of increasing organization efficiency. It would be necessary to make a more accurate study of human nature, select the right man for the respective position, show the workman that it is quite feasible to do from two to four times the present quota, and on the other hand provide working conditions that will be conducive to efficiency.

Economy of Colliery Boiler Plants

By D. Bronlie

The following is from a reprint from *Engineering* (London) July 25, and Aug. 1, 1919: I propose to give in this article the exact working details of 100 typical colliery steam boiler plants in Great Britain in order to undertake efficiently the whole question of national coal economy. I hope to show that the average mean working efficiency in colliery steam boiler plants is only 55.5 per cent and that by carrying out a reorganization of these plants on modern scientific lines it is usually possible to run them on 70 per cent. This will represent an average saving of about 21 per cent in the national coal consumption of, say, 18,500,000 tons per annum, corresponding to a saving of no less than 3,900,000 tons per annum. This saving can be obtained by burning the existing coal more efficiently, but in addition at least another 15 per cent equal to, say, 2,775,000 tons, can be saved by burning refuse coal, so that the total saving would be 36 per cent, or 6,600,000 tons per annum.

The figures given in this reprint are the result of tests of one week's duration.

The 100 plants have a total of 570 boilers comprising 500 Lancashire, 2 Cornish, 38 egg-ended and 31 modern tubular boilers. The typical boiler today is undoubtedly the Lancashire of an average of about 30 ft. x 8 ft. 6 in. The extremely low efficiency of the old egg-ended boiler will be noted, the average being less than 35 per cent as against, say, 55 per cent for the Lancashire. It is interesting to analyze the results obtained from the quality of coal used in the 100 plants. In the first place the two mathematical average figures for the 100 colliery boiler plants are 10,500 B.t.u. and 15.5 per cent ash, as compared with the figures of 259 typical boiler plants with 11,822 B.t.u. and 11.5 per cent ash.

The average price for the whole of the coal burned in colliery plants irrespective of quality would be about 50s. per ton. That is to say the coal bill of the whole colliery industry is about £18,500,000 per annum.

The almost universal practice of colliery plants is hand firing, and in the writer's opinion this is the correct method. In the 100 plants only five are mechanically fired and the average results were, if anything, slightly inferior to hand firing, quite apart from possible upkeep of the stokers. The figures for the 250 plants show 24 per cent mechanical firing.

In all the 100 plants, in not one case was any apparatus installed for determining regularly the feed water evaporated. In most cases 25 to 50 per cent of boilers in operation in collieries could be shut down and the same amount of steam generated with much better efficiency from the remaining boilers.

The average combined efficiency for the 100 plants is 55.52 per cent.

The plants are operated under very inferior conditions as regards output of boiler; 25 to 50 per cent of the boilers in collieries can be shut down. Practically no proper use is made of economizers and 15 per cent of the coal bill is wasted because of the lack of these.

The Lubrication of Ball Bearings

By H. R. TROTTER

At the present time there is, unfortunately, no instrument that will accurately indicate the true lubricating value of an oil or grease, and until such an instrument is devised, the selection of a lubricant must be more or less a matter of guesswork. A viscosimeter gives a comparative reading of the inertia of a liquid, but it does not indicate the value of a lubricant under working conditions. Furthermore, all authorities are not agreed on the desirable qualities of a lubricant. Many claim that a high surface tension is a requisite, and others lay great stress on adhesive qualities. All are agreed, however, that a lubricant should have the minimum of internal friction. Generally speaking, a lubricant for the plain-sleeve type of bearing requires a certain amount of adhesive quality to enable it to adhere to both the revolving and the stationary surfaces. It should have sufficient body to withstand the pressures. The lubricant film will, therefore, consist of three layers, which in operation approximate the features of a ball bearing in that one element is stationary, one rotating and one an intermediate layer consisting of globules, similar to the ball in a ball bearing. From this description the importance of body in a lubricant will be realized, and as the best and toughest material is required in the balls of a ball bearing, so is body required in the intermediate layer of a lubricant.

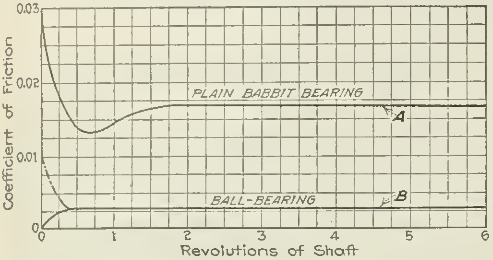


FIG. 1. FRICTION-COEFFICIENT CURVES OF A PLAIN AND A BALL-BEARING

The two cardinal points of successful sleeve-bearing operation are: (1) A design of such type as will permit of the formation and preservation of an oil film; (2) selection of a lubricant that will provide a film of maximum strength with a minimum of internal friction.

With a ball bearing, however, the problem is not so easily understood, but the important points to be remembered are: (1) The coefficient of friction is practically constant throughout wide ranges of loads and speeds; (2) metal-to-metal contact (an oil film only possible at very high speeds when slippage may take place); (3) the coefficient of friction is lower in an unlubricated ball bearing (at light loads and moderate speeds).

The first point is, of course, generally known, but the conclusion to be derived from this point has not been stated before to the author's knowledge; namely, the impossibility of an oil film between balls and races.

In Fig. 1 curve *A* shows the change of friction coefficient of a plain bearing under constant load and varying speed. The curve is self-explanatory and shows that a satisfactory oil film is not formed till a certain speed is reached. In the same figure curve *B* gives the friction coefficients of a well-made ball bearing and shows that the friction loss of a ball bearing is practically constant throughout wide ranges of speed. If an oil film were formed between balls and races, curve *B* would possess the same general characteristics as curve *A*.

The difference between the friction coefficient of a lubricated and an unlubricated ball bearing is shown in Fig. 2. This property of a ball bearing is not generally known and should not be used as an argument in favor of operating ball bearings without lubrication. From the foregoing statements it should be evident that plain bearings and ball bearings possess such radically different characteristics that a true comparison is impossible. It naturally follows, therefore, that practically all the accumulated experience of the lubricating engineer is of little value when analyzing ball-bearing operation.

The use of a lubricant with ball bearings is necessary to protect the highly polished surfaces of the balls and raceways, and to minimize the slight friction between the balls and ball retainer. The small amount of friction between balls and retainer can also be minimized by careful design. The principal requirement of a ball-bearing lubricant is chemical neutrality. The lubricant used must not contain over 0.10 per cent. acid or alkali. There are on the market many commercial lubricants that come within this limit, but very few are acceptable because of their tendency to develop acid with age or when operating at high temperatures.

Most of the high-grade oils can be used with safety, but many of the lubricating greases, while suitable for general purposes, are a positive menace to successful ball-bearing operation, not because of poor material used in the manufacture of greases, but because of the lack of scientific mixing methods The manufacturer is in no way to blame for this condition, because he is making grease for general commercial use and not for ball bearings. There are now on the market a few greases manufactured especially for ball bearings, but with one exception all those tested by the author have proved worthless and clearly indicate the maker's ignorance of the requirements.

Experience shows that the most satisfactory lubricant for ball bearings is a highly refined mineral oil having the proper viscosity and cold test for the installation. Greases should be used only where operating conditions require viscosities greater than can be obtained with a mineral oil.

Whenever a ball bearing is operated at high speeds, it is not advisable to run it submerged in a lubricant, and provision should be made to supply the oil from a pressure system. If such a system is not available, good results may be obtained by a large sight-feed oil cup. A few drops of oil per minute is all that is required.

At moderate speeds a heavy oil will generally give better results than a light oil. The substitution of a heavy oil for a light oil will generally result in a decreased operating temperature. This peculiarity may be explained by the fact that when the bearing is running at the actual operating speed, less opposition is offered to the rotation of the balls by the oil because of the inertia of the oil. In addition there is less churning and frothing with its resultant air pockets. Air pockets in a lubricant act as insulators and prevent the transmission of the heat generated to the outer casing where it can readily be dissipated.

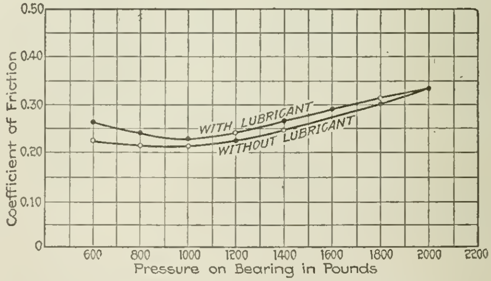


FIG. 2. FRICTION-COEFFICIENT CURVES OF A BALL-BEARING WITH AND WITHOUT LUBRICANT

All mineral oils used on ball bearings should be highly refined, filtered and contain a minimum amount of acid, alkali or sulphur compounds, and in order to insure the use of such oils the following specifications are suggested:

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*Abstract from a paper presented at the annual meeting of the American Society of Mechanical Engineers, New York City, Dec. 2 to 5, 1919

Free acid (calc. as oleic acid), maximum, 0.10 per cent.
Free alkali, absent.
Ash, trace.
Heat test (15 minutes at flash point), slight darkening, but no sediment.
Flash point (Cleveland open cup), minimum, 300 deg. F.
Fire test, minimum, 350 deg. F.
Viscosity at 100 deg. F. Saybolt Universal: Light oil, 100 to 200 seconds; medium oil, 200 to 300 seconds; heavy oil, 300 to 500 seconds; extra-heavy oil, more than 500 seconds.

Most of the high-grade mineral oils conform quite closely to these specifications. In connection with lubricating greases, however, the problem is more difficult. Many of the greases now on the market are entirely satisfactory for general purposes, but lack certain characteristics which experience shows to be highly important for successful ball-bearing lubrication.

A large number of greases contain lime-soap as thickeners, a few are of the soda-soap type, while others are a combination of both. The lime greases are valuable in that they can be used without harmful results where moisture is present. Their consistency, however, is more easily changed by heat than greases of the soda type. Ball bearing manufacturers are quite agreed that the limit of free acid in a grease should not exceed 0.10 per cent. calculated as oleic acid, and plenty of greases that meet this requirement are available.

It is essential that the grease be comparatively free from unsaponifiable fatty oil, or as expressed in the analyses, "neutral saponifiable oil." This specification is imposed because the unsaponified fatty oil has a tendency to become rancid or develop an acidity with age in service, particularly when operating at high temperatures. We have established a limit of 1 per cent., and this can be met in most of the compounds that are suitable in other respects.

One feature of grease lubrication that cannot be too highly emphasized is the importance of using a high-grade mineral oil. A grease may be perfect in every other respect, yet if a poor grade of mineral oil is used, the life of the bearing will be shortened.

Some manufacturers take advantage of the fact that a grease made with kerosene looks much the same as one containing high-grade oil and cheapen their product by using inferior light oils. It is desirable that a highly refined oil showing about 200 sec. viscosity Saybolt Universal at 100 deg. F. be used in the ordinary grease formula. In view of the high polish necessary on ball bearings, the elimination of abrasives such as sand particles, etc., is manifestly important.

At the present time there is no generally accepted method for determining the consistency or melting point of a grease.

The highest-grade ball-bearing greases are put through a milling process after compounding. This treatment insures very intimate mixing of all constituents and pulverizes any chance impurity to an impalpable powder. It is strongly recommended that all greases for ball bearings be so treated.

Graphite, despite its unctuous qualities, cannot be regarded as a true lubricant. It can, however, be used with success in plain bearings, as it fills in the interstices in the bearing surfaces and allows the true lubricant to operate efficiently. A modern well-made ball bearing with mirror-like finish has, however, practically no interstices in the balls and raceways. A perfectly finished ball shows no scratches when magnified 100 diameters, and furthermore, were there irregularities present, graphite would not eliminate them, as there is considerable difference between the sliding action of a plain bearing and the rolling action of a ball bearing.

Graphite, moreover, has a tendency to pack in the ball retainers and raceways, and a bearing that has been lubricated with graphite grease generally has a distinct wavy appearance in the ball paths. A recent brief test of a grease containing collodial graphite revealed the fact that while the graphite did not pack in the raceways, and the wavy ball paths were absent, the complete raceway presented a burnished appearance quite different from that obtained by the use of ordinary greases. The graphite packed hard in the ball retainer and could not be removed by dipping in gasoline. The use of graphite in ball bearings cannot, therefore, be regarded as beneficial, and its application is purely a question of economics.

Bearing for High-Speed Gears

According to *The Engineer,* London, K. Baumann and th British Westinghouse Electric and Manufacturing Co., Lo don, have patented a bearing for high-speed gears that supported in position by films of oil, which are maintained forcing the oil through one or more relatively small clearan spaces provided between the bearing and its support. In th way any vibration that may be set up is absorbed by the fil of oil, which provides a cushioning effect; also the positi of one bearing with respect to another may be adjusted forcing a greater quantity of oil through the clearance spa or spaces between one bearing and its support than throu the clearance space or spaces of the other bearing, and th adjustment may be made while the apparatus is in motic Accurate alignment of the coöperating teeth may be secur automatically by supplying the oil films to the different bearin of the gear from a single source.

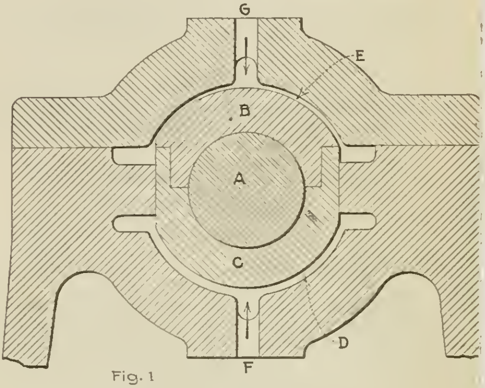

Fig. 1

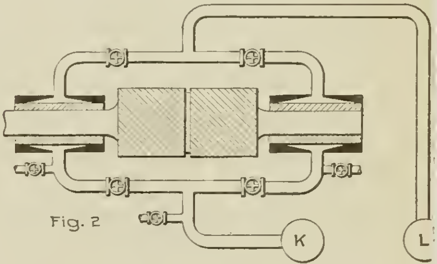

Fig. 2

FIG. 1. DESIGN OF HIGH-SPEED BEARING
FIG. 2. PINION SHAFT SUPPORTED BY TWO BEARINGS

Referring to Fig. 1, a shaft journal A is supported betwe upper and lower bearings $B\,C$. Between the lower beari and its housing and between the upper bearing and the c clearance spaces $D\,E$ are provided, and passages $F\,G$ le respectively into these two clearance spaces, through whi oil under pressure is forced, the bearing being maintained position by the oil films thus formed in the clearance spac The bearing is provided with vertical guide surfaces, whi coöperate with guide surfaces in the housing, and drains a provided on each side of the bearing for leading away t oil from the lower and upper clearance spaces respective With this construction the bearing may be raised by increasi the quantity of oil supplied to the lower clearance space as compared with that supplied to the upper clearance space

Fig. 2 shows a pinion, the shaft of which is supported two bearings, and each bearing may be of the form illustrat in Fig. 1. Oil is supplied to the lower clearance spaces by oil pump K and to the upper clearance spaces from a pump Throttle valves are provided in each branch pipe, so that t amount of oil supplied to the several clearance spaces a onsequently, the position of either bearing may be inde- endently adjusted as required. In addition to, or in substitu- ion for, the throttle valve, a by-pass or relief valves may be rovided for adjusting the quantity of oil supplied to both he lower clearance spaces at the same time or to either of hem independently. With this arrangement very fine adjust- nent of the position of each bearing can be obtained by manipu- ating the valves, all of which may be located in accessible ositions outside of the gear casing. Instead of supplying the il to the clearance spaces from a pump, a supply of oil may e tapped from the oil film of the journal at a point where it s under pressure, thus utilizing the well-known property of ournal lubrication for the generation of the necessary pressure. Vhere an external pump is employed, the oil may be used or lubricating the journal after passing through the clearance pace or spaces.

Consolidation of Power Plants

In reference to the extensions of the Kentucky & West irginia Power Co., Lothair, Ky., announcement has been nade as follows by Francis R. Weller, consulting engineer, Vashington, D. C.:

The Kentucky & West Virginia Power Co. acquired the ogan Light & Power Co., Logan, W. Va., the Tug River ower Co., Sprigg, W. Va., and the Kentucky River Power o., Lothair, Ky. The company supplies power to various nines in the southern part of West Virginia and eastern entucky. These are largely non-union fields and are de- eloping rapidly, so a very comprehensive program for en- argement of the power plants in the extension of transmis- ion lines is now starting. The power plant at Logan, having 5,000 kw. capacity, will be enlarged by installing two 15,000-kw. urbines. A new boiler house will be constructed with six 000-hp. water tube boilers, stokers and economizers.

At the Logan plant an 88,000-volt line will connect the Logan nd Lothair plants, a distance of over 100 miles. Construction as been started on this line and it will be built by the com- any's construction forces. At Sprigg a 3000-kw. turbine and ondenser is now being installed and it is intended to increase he capacity further by two 10,000-kw. turbine and surface con- ensers, also by building another boiler house.

At Lothair the boiler room will be extended, and two 833-hp. oilers with underfeed stokers will be installed, and a 3000-kw. urbine and surface condenser is being installed. The 44,000- olt distributing lines in the Logan district will be extended o serve new mining interests. The 33,000-volt transmission nes in the Sprigg and Lothair districts will likewise be ex- ended.

The company purposes installing a 10,000-kv.-a. step-down ubstation in Pikeville, Ky., on the Big Sandy River, which vill be on an 88,000-volt transmission line and a 44,000-volt istributing line extended from the Pikeville substation to sup- ly all the mines in the Big Sandy Valley. Nearly all the ontracts for the Logan work have been awarded with the xception of one for the power-plant building, including struc- ural steelwork.

R. E. Breed, of New York, is president; George N. Tidd, New York, vice-president; H. T. Hartman, Philadelphia, vice- resident and general manager; A. J. Darrow, manager, Logan ivision; M. C. Funk, manager, Sprigg division; W. F. Fickle, manager, Lothair division.

Committee on Water Power Development

President R. H. Ballard announces that the Committee on Vater Power Development under the chairmanship of Frank- n T. Griffith, president of the Portland Railway, Light and ower Co., Portland, Ore., will include the following per- onnel:

William A. Brackenridge, president, Southern California dison Co., Los Angeles; John A. Britton, vice-president and eneral manager, Pacific Gas and Electric Co., San Francisco; I. T. Edger, president Mississippi River Power Co., Keokuk, owa; G. C. Egbert, consulting engineer, Niagara Falls Power o., Niagara, N. Y.; Mortimer Fleischhacker, president, Great Vestern Power Co., San Francisco; H. I. Harriman, president, New England Power Co., Boston, Mass.; D. I. Huntington, president, Washington Water Power Co., Spokane, Wash.; H. F. Jackson, president, Sierra & San Francisco Power Co., San Francisco; Frank M. Kerr, vice-president and general manager, Montana Power Co., Butte, Mont.; W. S. Lee, chief engineer, Southern Power Co., Charlotte, N. C.; A. W. Leonard, president, Puget Sound Traction, Light and Power Co., Seattle, Wash.; J. D. McKee, vice-president, California-Oregon Power Co., San Francisco; G. W. Talbot, president, Pacific Power and Light Co., Portland, Ore.; A. B. West, vice-president and general manager, Southern Sierra Power Co., Riverside, Cal.; A. G. Wishon, vice-president and general manager, San Joaquin Light and Power Co., Fresno, California.

A complete investigation of the water-power resources of the country, both developed and undeveloped, will be undertaken by this committee. The great aid to national industrial and agricultural development that commercial and economic use of the nation's natural resources in water supply will be fully set forth for the benefit of the industry at large, bankers and investors. A study will be made respecting the practical application of pending national legislation on the subject and of the economic advantages to be obtained through a more general interconnection of water power systems.

New Power Plant Being Built on the San Joaquin River

To meet the increasing demands for power in the San Joaquin Valley, the San Joaquin Light and Power Co. is building a new plant on what is known as the Kerckhoff power site, near Auberry, Calif. This plant will use the entire flow of the San Joaquin River. A dam 150 ft. high is being built across the river about four miles about Auberry, and from here the water will be diverted into a 17-ft. tunnel 17,000 ft. long to the forebay, from where it will pass through three 8-ft. steel penstocks to the hydraulic turbines in the power plant.

The turbines are of the vertical Francis single-runner type, and each is capable of developing 15,000 hp., and drives an alternator of 14,200-kv.-a. capacity at 80 per cent. power factor. The revolving element of each machine will be supported on Kingsbury thrust bearings. Excitation of the alternators will be obtained from two 300-kw. exciters driven by 500-hp. Francis-type turbines. The power developed in the plant will be stepped up to 110,000 volts through three banks of transformers, each bank consisting of three 5000-kv.-a. units, or a total of 15,000 kv.-a. to the bank. It is estimated that the development of this project will cost $5.000,000.

THE FIRST ENGINEER

Rapid Adoption of Automatic Substations*

The first automatic substation control was put into operation on Christmas Eve, 1914, in the Union substation of the Elgin & Belvidere Electric Ry., and in the following August the two remaining substations of this road were equipped. The success of the venture immediately attracted the attention of railway engineers so that several automatic-control equipments and complete substations were purchased and installed in 1916. It is of interest to note that the second railway company to install an automatic railway substation decided to operate a semi-outdoor station, provision being made for housing only a 500-kw. rotary converter, the switchboard and the drum controller. At this time two other systems decided to install a total of 12 automatic equipments. One of these early installations was the first portable automatic substation. In 1917 the first installation involving the operation of two synchronous converters in series was made, and in 1918 two synchronous converters were first automatically operated in parallel. Two more portable automatic substations were put into service in this year. Four and one-half years after the first experiment was made, there were 35 full-automatic and two semiautomatic, or remote-controlled, substations in actual operation and an additional 31 automatic and four semiautomatic equipments stood on order with manufacturers. These 72 equipments control several types of synchronous converters and motor-generator sets of capacities varying from 200 to 2000 kilowatts.

On May 1 a number of control equipments sufficient to control 37,500 kw. of rated machine capacity had been purchased. Thus far the tendency has been to apply automatic control more generally to machines having rated capacities of 500 kw. and under, the total number of machines coming within this range being 58. This number includes twenty 300-kw. and twenty-eight 500-kw. units. A good inroad is, however, being made on machines of larger capacity, as one 1000-kw. synchronous converter is now operating automatically and six 1000-kw. synchronous converters, one 1000-kw. motor-generator set, two 1500-kw. synchronous converters, and one 2000-kw. motor-generator sets are on order and will probably be put in service before the close of 1919.

While 44 stations are to receive 25-cycle energy, a total of 18 stations are to receive 60-cycle energy and 8 stations will operate at odd frequencies including 30, 35, 40 and 50 cycles. The high-tension line voltage varies from 2200 to 66,000. The trolley voltage supplied is generally standard at 600 volts direct current, excepting one 1200-volt direct-current system and one 1500-volt direct-current system.

While the largest synchronous converter yet to be automatically controlled is a 1500-kw. machine and the largest motor-generator set a 2000-kw. machine, there is at the present time in operation a 3000-kv.-a. synchronous condenser. The first automatically controlled waterwheel generating station, which contains three 500-kw. generators arranged to operate in parallel either under the influence of full-automatic control at the generating plant or controlled if desired by an operator in the main steam-generating station at a distant point, was put in operation in 1918. The success of this installation without question makes possible the development of a considerable number of small water powers that otherwise could not be developed because of the cost of operating labor.

Several companies have chosen automatic equipment in consideration of the saving possible from the elimination of light load losses, as well as from a consideration of saving in labor. The largest figures received gave an estimated saving of $400 per annum on a 300-kw. station and $700 on a 500-kw. station. One company installed a 250-kw. automatic station to replace a floating battery between two substations ten miles apart, in preference to spending $5000 for necessary repairs to the battery. When some of the automatic substations were built in new locations, however, it was in several cases possible to remove feeder copper which possessed a value sufficient to offset in part the cost of construction of the substation building with its equipment. In an exceptional case the cost of construction of a two-unit substation containing two 300-kw. synchronous converters was more than offset by the value of the feeder copper that was removed from the distribution system, and a more satisfactory line voltage was maintained on the line as a whole. The most notable saving in copper was made in Des Moines, where, through the installation of a system of automatic substations, an amount of feeder copper was taken down which, at 20c per pound, was worth $90,200, and at the same time a substation and distribution system were obtained which cost according to estimate $141,700 less than an equivalent system to give the same voltage regulation would have cost had additional manually operated synchronous converters been placed in the central power station and additional feeder copper put up on the outside lines. As an example of another exceptional case, it has been estimated that one important interurban line in central New York State, "because of its surplus feeder capacity can, by adopting automatic substations and removing part of this copper, make an annual saving of $24,000 with approximately zero investment." These examples are unusual, but are given to illustrate the possibilities that are offered in not a small number of cases.

It was brought out in the discussion on this report that at the present time the economic limit in automatic substation capacity is about 6000 kw.; above 6000 kw. it is more economical to install manually operated equipment.

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*Abstract from the report of the Committee on Power Generation presented at the convention of the American Electric Railway Engineering Association, at Atlantic City, N. J., October, 1919.

Practical Aspects of Employees' Representation*

By E. B. Tolsted

There has been so much misused power on both sides of industrial disputes that some method must be developed to eliminate it in the interest of the nation as a whole. To careful thinkers the solution lies definitely along the line of a clear understanding by each side, of its own attitude, of the problems of the other and of their joint relation to society. Just how this understanding is to be brought about is the big problem before the industrial world today.

The most prominent plan at present for the solution of this problem is the employees' representation, or so called "shop committee" plan. Many employers consider this plan better than the labor union, and under proper circumstances it can and does work in connection with the unions.

There are at present about 150 employees' plans in operation in the United States, and this paper is the result of a personal investigation of about fifty of them. Among these there is a wide variety of scope and power. An individual case may provide simply an orderly method for presenting grievances, it may provide machinery for collective bargaining with reference to wages, hours and working conditions, or it may enter into any or all of the relations between the employer and the employees. Structurally, it may be very simple or very elaborate. Its power may be simply advisory, or the employees' representatives may be given final authority in one or many of the questions that may come up. The fact should be emphasized that in no plan investigated had the control gone as far as what is known as "Industrial Democracy."

Results Accomplished by Works Committees

Several years ago one employer, who was working under a representation plan, stated after ten years of experience that about 90 per cent. of the employees' complaints were justified. In the large majority of the cases brought up the decision was immaterial to the employer. Under the older system many of these complaints smoldered unseen until they caused real trouble, when the employer would have gladly adjusted them if proper means had existed to bring them to his attention.

Many grievances are the result of petty tyrannies on the part of foremen or other subordinate authorities. When there are adequate means of making these tyrannies public, they usually disappear before they can come before the committees.

Under some plans the shop committees have been given very extensive authority in matters of discipline. In some cases penalties have been lighter than when the rules were made by the employers, being principally fines and suspension rather than discharges, but in general the added force of censure from fellow employees has reduced the number of offenses. In other cases the penalties have been so severe that the company has been forced to request their modification. One company gives final authority over discharges to an arbitration board from the employees' association. At hearings before this board employees may be represented by council. A rolling-mill company reports greatly improved discipline as a result of a shop committee.

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*Abstract of paper delivered before the eighth annual Safety Congress of the National Safety Council at Cleveland.

Many concerns report greatly increased coöperation as a result of their works committees. One very definite factor is that representatives take back to the workers a more adequate appreciation of the problems of the management. On the other hand, the management learns something of the problems and ambitions of the employees.

One board of directors authorized the employees to elect a committee to take complete management of about 400 company houses. A certain sum of money was allowed to be spent by the committee in upkeep. While some rather serious blunders were made, the company feels well repaid for the cost.

Several reports showed increased production with no increase, or comparatively small increase, in cost, after the introduction of the representative plan. This was attributed to the better plant spirit brought about by the committees. Other advantages reported included reduction in turnover, in absence, in tardiness, and in wasted time in the shop.

Several reports noted that at the first elections under the plans, a number of "radicals" were chosen The employees soon learned, however, to distinguish between mere talkers and competent representatives.

Without exception, where a shop committee has been in operation for several months, the company reports that it has revealed capacity for leadership among employees which otherwise would have been suppressed. One company makes it a practice to select assistant foremen from among the employees' representatives.

Some cases have been reported where the more intelligent and fair-minded representatives incurred the distrust of the men because they seemed to side too much with the employers. This shows that too much agreement between committee and management may lead to more trouble than disagreement. It is likely to breed distrust, and that is the main thing these plans are working to abolish

The study reveals the fact that while the matters of personal grievances are the first questions to come up, the larger questions of policy, shop practice, efficiency, etc., are soon taken up and become the predominating issues.

Installation of Representative Plans

Industrial representation has been successful under such wide variety of conditions that no specific condition seems responsible for success. No two plants will function the same way. A few general suggestions may be valuable, however, for consideration when contemplating the introduction of a plan.

Install a representation plan only during peace times. Trying such a plan in the face of the antagonism present when a strike is threatening or in progress simply invites defeat. It has always worked this way.

Do not impose a ready-made plan. Let the men help work it out gradually. The plan will be better and, what is more important, will be received more favorably.

See that the plan is simple. The joint committee form seems to give best results. Separate meetings should be arranged, however, so that the men may discuss matters without the restraining presence of the "boss."

Some plans are very limited in scope, while others are very broad. Both extremes give trouble. A good way is to start with somewhat narrow limitations and broaden as the committee educates itself.

We advise that every employee, man or woman, citizen or alien, be made to feel that he has a part in the plan's operation. See that everybody understands it. Spare no effort to educate *every* employee. In one plant only citizens had a vote, although of course anyone could present grievances. A group of foreigners struck because they could not understand that they had any share in the plan at all. Make it plain also that the plan does not interfere with membership in unions or with existing relations of the management with the unions.

Keep complete records of meetings and make them accessible to everybody. Usually, the best results follow when meetings are held in working hours. The interest of representatives is held better that way.

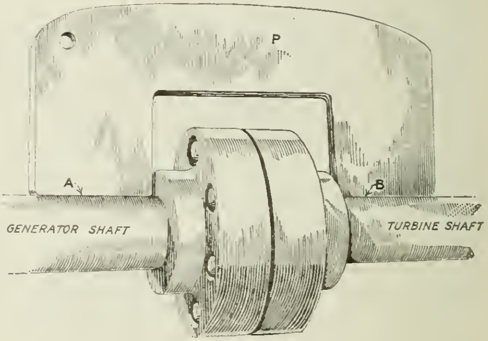
The degree of success or failure of any plan of employees' representation depends not upon its form, the size of the company, the nature of the industry or the character of the working force, but upon the understanding of what the plan means and upon the mutual confidence existing between the employer and employees. There must at least be a foundation of confidence and cordiality if the management and men are to strive together toward an industrial ideal.

The ideal industrial organization is one in which there is friendly coöperation throughout the entire membership with a ready recognition not only of the rights, but the feelings of every member. This result can be attained, not only because it is theoretically sound, but because it has been done.

Balancing and Alignment of the Alternator Rotor*

By C. Sylvester, A. M. I. E.E.

The final balancing of alternator rotors must often be done after the machine is permanently erected. In the shop the rotor is balanced, statically and dynamically, before the winding is begun. Any irregularities due to the winding are then taken care of by the balancing weights. These weights are flat pieces of steel free to make in circular grooves, concentric with the shaft, in the end of the rotor. They are held in their proper position by setscrews which are screwed into tapped holes in the bottom of the grooves. There are usually two such weights on each end of the rotor. Excessive vibration of the rotor is sometimes accompanied by firing at the points on the alternator-end shields where the rotor shaft projects through the shields near the slip rings. This simplifies the balancing, as the points that have been in contact will be marked by the firing.



METHOD OF TESTING SHAFT ALIGNMENT

There has been considerable discussion regarding the types of balancing bars used by the various manufacturers. For large rotors the bar should be of box section, having a depth at least one-eighth of its length and sufficient surface on top for a load of 1500 lb. per square inch.

Next to balance, the proper alignment of the rotor shaft is probably the most important feature of the erection work. Checking the alignment of the alternator and turbine rotors is not easy, as a deflection of as much as 0.005 in. is sometimes noted on the bedplate leveling pads after the turbine and generator are put in place.

The illustration shows a scheme for testing the alignment of the two shafts, which has come under the writer's observa-

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*Abstract from an article in the *Electrical Review*, London.

tion. A steel plate, marked *P*, is cut so as to pass over the coupling between the turbine and generator shafts. The edges *A* and *B* are carefully ground to a straight line. When the plate is placed in position on the shafts, the alignment will be perfect only if the plate makes contact with the shafts at all points.

The writer remembers a case where the shafts of a 6000-kw. turbo-generator was lined up by the method just described. When run at full speed and full load no lateral movement of the shaft was observed, indicating that the alignment was correct. It was noticed, however, that the oil temperature of the inner bearing was materially increased. This was explained by considering the shaft as a beam supported at three points (the bearings) and loaded at two points (by the generator and turbine rotors). If the bearings are in line, the inner bearing will support about twice its share of the weight. This may be corrected by adjusting the middle bearing so as to be slightly lower than the outer ones.

[Some of the points in the foregoing article seem rather unusual, and *Power* invites discussion from any readers who have had experience along the lines mentioned.—EDITOR.]

Boston Tech Proposes a New Relation with Industry

Big possibilities for the future of American engineering schools are inherent in a plan which the Massachusetts Institute of Technology is now developing to put contributions to its endowment fund upon a sound business basis. The Institute, it may be recalled, is seeking four million dollars from the public in an endowment fund in order to obtain the like amount already promised by the mysterious Mr. Smith, the income from this fund to be used to pay more nearly adequate salaries to the members of its instructing staff. In the quest of this amount, Technology has decided to go before the great industrial corporations and say, in effect: "This Institute is a source of supply of trained men to your organization. You are calling for more and more of these trained men. If this school is to furnish its quota of them, more money must be found somewhere."

The officers of an industrial organization are able to see the full force of the argument. They would like to contribute, but must take a vote of stockholders to comply with the legal technicalities. Contributions must be made before Jan. 1, 1920, to take advantage of Mr. Smith's offer. So the Institute proposes not a contribution, but a contract, something any corporation may enter into by vote of the management.

This contract provides for the payment of an annual fee by the corporation, in return for which the Institute is to permit the corporation to have the use of its library, the opportunity to consult its professors and the first chance of hiring Technology men.

By this new plan the Institute would receive much needed financial assistance and the corporations availing themselves of it would receive technical service the value of which it is difficult to estimate. American industry has long been in need of a clearing house of scientific knowledge. If industry avails itself of the present disposition of the Massachusetts Institute of Technology to become a bureau of research, the importance of the decision will be very far reaching.

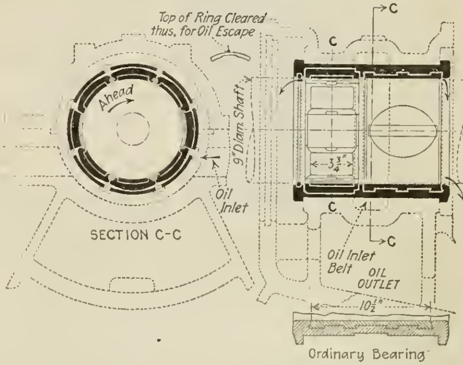
Fears that the Technology proposal may conflict with the work of the consulting engineer are answered by the obvious fact that the problems submitted to the Institute would in general be beyond the scope of the private engineering firms to handle, and by the further fact that the consulting experts of the country are already swamped with the unending questions submitted to them for solution.

The proposition is one that may become a tremendously important factor in determining the position of the United States in the commercial and the economic rivalry of the nations during the next decade.

The Michell Journal Bearing

The following abstract of an article appearing in a recent issue of *The Engineer*, London, should prove of interest as describing the application of a new principle to journal bearings. Up to the present the Michell principle has been used almost exclusively for thrust bearings for marine engines. The bearing surface is made up of a number of so-called pads, each of which is mounted on a pivot so that it is free to take up the proper alignment automatically. After a long series of shop experiments the Engineer-in-Chief of the British Admiralty agreed to the installation of a set of Michell bearings on one turbine of H. M. Destroyer "Makay." For comparison the other turbine was equipped with the ordinary form of bearings.

The construction of the bearing is shown in the cut, where it will be seen that six pads are arranged in a steel shell in the bearing, the tipping being permitted by the reduced curvature of the back of the pads. The total projected area of white metal of the low-pressure Michell bearings is only 20.649 sq. in., as compared with 94.5 sq. in. of the ordinary type of bearing for the same load of 13,328 lb. The pressures on the bearings are 549 lb. per sq. in. and 120 lb. per sq. in. respectively. The cut also shows the comparative sizes of the two types of bearings. As this was an experimental installation, the shells of both bearings were made the same size. The part not occupied by the pads in the Michell bearing is a clearing fit on the shaft and would, of course, be dispensed with in an entirely new design.



	MICHELL JOURNAL BEARING	ORDINARY BEARING
Weight on One Bearing =	11,328 lb.	11,328 lb.
Projected Area of White Metal =	20.649 sq. in.	94.5 sq. in.
Pressure per sq. in. (Projected Area) =	549 lb.	120 lb.
Rev. per Minute at Full Power =	1,300	1,800
Peripheral Speed per Second =	70.5-ft.	70.5-ft.

MICHELL JOURNAL BEARING ON H. M. DESTROYER "MAKAY"

An indication of the success of the experiment was given during the two days' progressive trials of the "Makay." The oil came away from the Michell bearing about eighteen degrees cooler than that from the ordinary type.

Another interesting feature was the use of the Michell principle to support the thrust collar and shaft. In this case the outer surface of the thrust collar was used as a journal.

The use of the Michell thrust bearing on the "Makay" permitted the introduction of an ingenious thrust-indicating device. The abutment ring carrying the thrust pads was supported by a number of small rams working in cylinders. These rams were supported in turn by oil under pressure in the cylinders. The pressure necessary to support the rams, of course, gave a measure of the thrust.

Byllesby Properties to Increase Capacity 100,000 Hp.

Rapidly increasing business in territories served by Byllesby electric properties has made imperative additional generating capacity. Three new power stations with a total initial capacity of 33,500 hp. have been planned for immediate construction and further extensions are receiving attention

One of the new stations will be located in Southern Minnesota, where demands of the Southwestern territory served by the Northern States Power Company have exceeded the capacities of the several divisions concerned. A new steam station will be constructed at this point and one 13,500-hp. steam turbine will be installed. Provision will be made for a second unit of 20,000 hp. to be installed later. Condensing water will be obtained from the Minnesota River and present equipment will include three 1165-hp. boilers with coal and ash handling machinery, etc. The improvement is expected to be completed within a year.

A new station with an initial capacity of 10,000 hp. will be constructed in Western Oklahoma to take care of the growing demands upon the Muskogee, Sapulpa and Drumright Divisions of the Oklahoma Gas & Electrical Company. Condensing water will be obtained from the Arkansas River.

The third station will be constructed at Pueblo, Colo., on the present power house site of the Arkansas Valley Railway Light & Power Company. The present power station with a capacity of 7500 hp. will be maintained and the new station with a present capacity of 10,000 hp. will be constructed adjacent to it. This improvement, like the others, is necessary because of increasing business in present territory and not because of expansion of territory.

Sale of Electric Generator Sets

The Director of Sales announces that the Surplus Property Division, Office of the Quartermaster General of the Army, is offering for sale 400 gasoline-driven electric-generator sets, with switchboards and gasoline tanks, which have been declared surplus by the War Department and on which offers will be received at any time by the Surplus Property Division, Munitions Building, Washington, D. C.

The generator is a 25-kilowatt direct-current commutating pole type. Either 115-volt two-wire or 230-volt three-wire generators can be supplied. The engine is of the closed, four-cycle, single-acting, vertical type, with four cylinders, and is capable of operating the generator at full load indefinitely and at a 25 per cent. overload for two hours. The sets are high-grade in every respect and combine a number of improved safety and gasoline-saving features.

These machines are designed for close regulation, which makes them very desirable for small electric-light and power plants, such as are required by stores, apartment houses, hotels, small factories and even small towns. Owing to the present coal shortage and the curtailment of electric current in many cities and towns throughout the country, these gasoline-driven generators should prove particularly useful as auxiliary or emergency lighting and power equipments.

The sets which the Government is offering for sale are new and have been carefully stored since they were purchased about a year ago. They are packed in the crates in which they were shipped from the factory. They are located at Schenectady, N. Y., and New Cumberland, Penn., and will be shipped promptly upon approval of submitted offers.

Inspection of the machines, switchboards and tanks may be made at the points of storage, or complete specifications may be obtained from the Surplus Property Division, Munitions Building, Washington, D. C. Information relative to the terms of sale, storage points, etc., may be obtained from the same office.

Meeting of the American Welding Society

Friday evening, Dec. 12, the American Welding Society held a meeting in the Engineering Societies Building, New York City, at which discussion of Professor Hudson's theory of arc welding was the chief feature of the program. Comfort Adams, president of the society, was in the chair. Fred E. Rogers, of the Davis-Bournonville Co., was to read a paper "Gas Cutting"; Alfred Kinsey, professor of shop practice, Stevens Institute, prepared a paper entitled, "A Gas-Welding Operation" dealing with gas welding a large pipe which was to be several feet underground. This paper, read by Mr. Mills, of the society, was highly interesting to nearly all branches of engineering. Many of the welds were made aboveground, yet several were made with the pipe in its deep trench. Overhead welds were made.

Mr. Forbes, secretary of the society, gave a brief but illuminating description of Professor Hudson's theory of arc welding. This theory assumes that the metal used to join the parts to be welded is carried to the parts in the form of minute globules, carried against gravity as well as with or or by it. A number of men, distinguished for their active interest in welding, were scheduled to discuss the theory. Three were present: O. H. Eschholz, of the Westinghouse Electric and Manufacturing Co., who led the discussion; C. J. Holslag, Electric Cutting and Welding Co.; and W. E. Ruder, of the General Electric Co. Those who have been interested in the art regretted that D. C. Alexander, of the Quasi Arc Weldtrode Co.; Mr. Armstrong, formerly associated with Mr. Alexander, and Mr. Miller, of Rochester, were not there to participate.

A. J. Deppler, chief engineer, Metal and Thermit Corporation, had a paper with motion pictures on "Thermit in Rail Welding."

Bureau of Mines Annual Report

The Annual Report of the Bureau of Mines to the Secretary of the Interior for the fiscal year 1918-19 has recently been received. Under the heading of "Some Urgent Needs of the Bureau," reference is made to coal-distillation processes and to the petroleum situation. Low-temperature distillation processes are being devised to produce a fuel little if any higher in cost than soft coal, in order to abate the present smoke nuisance. There is need for a clearing house of information as to what is being done in this line as well as for the study of possible byproducts, which alone can make these processes financially successful. The consumption of petroleum and its products is rapidly increasing, but the production of crude oil in the United States probably cannot be increased, and underground reserves are nearly 40 per cent. exhausted. The Bureau has already accomplished a great deal in the elimination of waste in the exploitation of oil and gas and hopes to do considerably more during the coming year.

In the Pittsburgh station of the Bureau, a general survey of the use of powdered coal is planned, with the purpose of issuing a bulletin giving the facts without bias. Many of the published articles on powdered coal were prepared by people interested in manufacturing powdered-coal equipment, and some of this information is misleading. Arrangements have been made for research work to determine how boiler furnaces should be designed to eliminate the troubles at present met in burning powdered coal. Particular attention will be given to the formation of slag in the furnace and to the disposal of ash.

An investigation of the transfer of heat from hot furnace gases to the water of the boiler is under way. The plant for this work consists of a tubular boiler 20 ft. long, and a gas furnace. The temperature of the gases before entering the boiler, along the path of the flow, and after leaving the boiler, and the volume of gases passing into the boiler tubes will be measured precisely. In connection with this work measurements will also be made of the heat transmission through the furnace wall.

In the field of combustion, tests have been made to obtain data as to the effect on the combustion processes of water-cooled surfaces as compared with a firebrick arch. Two types of boiler furnaces, the side-feed and the hand-fired, have been tested at the Pittsburgh station.

The Petroleum Division has assisted several Government organizations in drawing up specifications for the purchase of various grades of motor fuel. The division is represented on a committee whose duties are to standardize specifications for all petroleum products used by Government departments. Other activities of the Petroleum Division included investigations of the production of gasoline from heavier oils by the vapor-phase cracking reaction, also a comparison of motor fuels in supercompression motors. In April, 1919, this division undertook to determine the character of motor gasoline sold throughout the country. About eight hundred samples, collected from all parts of the country, have been analyzed and the results tabulated and classified. This gasoline survey is the most comprehensive that has ever been made and is expected to help materially in the formation of the Government standard specification.

New Publications

BOOK REVIEW

APPLIED SCIENCE FOR METAL WORKERS. By William H. Dooley. Published by Ronald Press Co., New York, 1919. Cloth, 479 pages; 5 x 7 in.; 207 illustrations.

This book is primarily intended for use in technical, industrial, apprentice and continuation schools and for science classes in secondary schools, and covers distinct phases of industrial education, such as elementary mechanics, chemistry, generation of electricity, steam and steam engines, gas engines, machine-shop practice, etc. The subjects are treated in a clear and easy-to-understand manner so that technical and apprentice students will understand the actual work they do in the shop. If there is one criticism that can be made of the book more than any other, it is that the author has attempted to deal with too many subjects within the allotted space, and necessarily the treatment in some cases is superficial. Although this book was written primarily for use in the classroom, the home student will find much in it of interest.

"THE TECH ENGINEERING NEWS." This is the title of a monthly publication to be issued shortly by the undergraduates of the Massachusetts Institute of Technology, Cambridge, Mass. The purpose of the paper will be to keep its readers informed of current events of interest in the field of industry, the most recent advances in engineering science and of the results of researches and original investigations.

Obituary

John F. Barker, formerly president of the Gilbert & Barker Manufacturing Co., Springfield, Mass., died of heart failure on Nov. 21. Mr. Barker went to Springfield in 1862 and was employed at the water shops of the United States Armory, where he remained until the founding of the Gilbert & Barker Co. in 1865. He was treasurer and manager of the company until 1884, when he was elected president, which position he held until his retirement in 1911.

Thomas L. Delahunty, secretary and business manager of the Marine Engineers' Beneficial Association, and president of the Marine Workers' Affiliation, died suddenly at Charleston, S. C., on Dec. 14, of heart disease. Mr. Delahunty was born in Charleston, S. C., and at the time of his death was on a visit to his mother. He was 54 years of age. He was educated at the local schools in his home town and followed the sea for 25 years thereafter. For the last 10 years he has been active in the uplift of the marine engineers. Mr. Delahunty was a widower and is survived by his mother, five daughters and two sons.

Charles A. Moore, who was for the past eight years supervising engineer of the Joseph Dixon Crucible Co. and consulting engineer of the American Graphite Co., died at his home in Jersey City on Dec. 5, after a brief illness. Previous to his connection with the Dixon company Mr. Moore was with some of the best-known firms in the Metropolitan district. He was the first chief engineer of the first propeller-driven ferryboat to ply across New York Harbor. He was chief engineer of the Western Electric Co. for six years and chief engineer of the Brooklyn Rapid Transit Co. for nine years. He was born in Maine 64 years ago, but spent the greater part of his life in the vicinity of New York. He is survived by his widow, two daughters, one son and five grandchildren.

H. L. Gantt, well-known industrial engineer, died at his home in Montclair, N. J., on Nov. 23. He was born in Calvert County, Maryland, May 20, 1861. He was educated at the McDonogh School, Baltimore, Md.; in 1880 he took the degree of A. B. at Johns Hopkins University, and in 1884 the degree of M. E. at the Stevens Institute of Technology. Since 1884 he has specialized in the field of industrial management, and has been celebrated throughout America for much original and brilliant work in this line. He was the author of several books and articles on industrial-management problems. One of the most important contributions to the literature of management is his book, "Work, Wages and Profits." He was a member of the American Society of Mechanical Engineers, was manager 1908-11 and vice-president 1913-15. He was also a member of the Society of Naval Architects and Marine Engineers, American Geographic Society and Beta Theta Pi. He belonged to the Engineers' Club, Machinery Club and Johns Hopkins Club. For some time he has had a consulting office in the Singer Building, New York City.

Personals

Albert A. Casey has joined the sales engineering staff of the American Steam Conveyor Corp. at Cincinnati, Ohio, which territory is under the managership of Henry P. Thompson.

George A. Miller, after completing a course in mechanical engineering at the Kansas State Agricultural College, has become connected with the turbine-research department of the General Electric Co., at Lynn, Mass.

Fred D. Harger, former manager of the F. D. Harger Co., of Buffalo, has accepted a position as vice-president and general manager with the Mono Corporation of America, 257 Washington St., Coal and Iron Exchange, Buffalo, N. Y.

Charles B. Hart, for some time superintendent of the light and power department of the Fort Wayne & Northern Indiana Traction Co., has been appointed chairman of the commercial section of the Indiana Electric Light Association.

H. G. Bain, until recently attached to the San Francisco sales office of the Midvale Steel and Ordnance Co., is now a member of the Tacony Steel Co.'s sales organization and will represent that company in the upper part of New York State.

George M. Brill, who before joining the United States service two years ago, specialized in industrial-plant management, will resume his practice in New York City, at Room 2607, Singer Building, until May 1, 1920, when he will remove to the Guaranty Fifth Avenue Building.

John E. MacDonald, formerly Chicago manager of the vapor heating department of the Illinois Engineering Co., has become associated with the Coon-De Visser Co., Detroit, Mich. Mr. MacDonald is one of the pioneers in the development of apparatus designed for vapor and vacuum heating.

Dr. F. G. Cottrell, chief metallurgist of the Bureau of Mines and inventor of the Cottrell process for utilizing smelter fume by extraction of arsenic and various other commercial chemicals from the noxious gases, has been named assistant director in charge of all investigative and scientific work.

Lieut. Col. Jess E. Jurgensen, who while engineer of the St. Regis Hotel in New York, instituted systems of training and education which have endeared him to many New Yorkers, is management engineer of the Acme White Lead and Color Works, at Detroit, Mich., having accepted that position on his discharge from the army.

Myron T. H. Blanchard, lately with the Hydraulic Pressed Steel Co., is a recent addition to the Cleveland sales force of the Tacony Steel Co. Mr. Blanchard has had considerable metallurgical experience, having been connected with the metallurgical departments of the Bethlehem Steel Co. and the Canton Spring and Axle Co. of Cleveland.

Charles Eugene Schneider, president of the French Industrial Commission to the United States, had the honorary degree of doctor of engineering conferred upon him on Nov. 24, by Dr. Alexander C. Humphreys, president of the board of trustees of Stevens Institute of Technology, Hoboken, N. J., before representatives of the various branches of the engineering profession.

N. H. Holifield, for several years superintendent of the Laurel Light and Railway Co., and J. J. Mundell, for a number of years head bookkeeper for the same concern, have left for Jennings, La., where they have invested in a rice plantation and will engage in farming. Mr. Holifield began work with the company as a laborer and assisted in the erection of the power plant. John Bagley, of McComb City, will succeed him.

W. W. Freeman has been unanimously elected president of the Society for Electrical Development, succeeding Henry L. Doherty, who has held the office since the founding of the society nearly six years ago. Mr. Freeman is well known to all branches of the electrical industry. He is president of the Union Gas and Electric Co., of Cincinnati, Ohio, and has been successively chairman and vice-chairman of the Public Policy Committee of the National Electric Light Association for a number of years.

Russell W. Stovel who recently returned from France,, where as lieutenant-colone of engineers, he served as chief of the Terminal Facilities Division of the Army Transport Service, has been appointed a consulting engineer o Westinghouse Church Kerr and Co., Inc., and, as a member o that organization, wi devote his entire time to the company' electrical and mechanical work. Mr Stovel has had an unusually comprehensiv experience in the electric and mechanica problems connecte with central power station and steam-railroad electrificatio work. He was graduated from McGi University in 1897 with the degree of electrical engineer, and the following yea entered the employ of Westinghouse Churc Kerr & Co. He soon became an assistan engineer, then successively engineer-in charge and mechanical engineer of th company, and finally a managing enginee In 1914 Mr. Stovel left the Westinghous Co. to become managing engineer for Gibb & Hill, consulting engineers, of New Yor For this company he had direct charge the Paoli and Chestnut Hill electrificatio of the Pennsylvania RR., the Elkhor Grade electrification of the Norfolk Western Ry., and the electrification of th New York Connecting Ry.

M. S. Sloan, president of the Brookly (N. Y.) Edison Co., has accepted the ap pointment by President R. H. Ballard the National Electric Light Association, a chairman of the committee on Electric Resources of the Nation. Mr. Sloan organizing a committee to handle th great subject, representative of a branches of the industry. The committee report, to be presented at the annual convention to be held in Pasadena, Calif., Ma 18-21, 1920, will be of inestimable value the industry at large, and in the natu of a textbook be of particular assistance the small companies throughout th country. The present status of electric development in the United States, bo private and municipal, will be noted, an the comparisons drawn between differe sections of the country, and betwe private and municipal operation, shou prove to be very interesting.

R. H. Ballard, president of the Nation Electric Light Association, reports th Frank M. Kerr, vice-president and gener manager of the Montana Power Co., h accepted the chairmanship of the commi tee on Steam Railroad Electrification. T Montana Power Co., of which Mr. Kerr the operating executive, is now furnishi the power supply for the operation of 6 miles of Chicago, Milwaukee & St. Pa RR. in Montana and the Pacific Northwe and consequently he is in a position speak with authority on the subject railroad electrification from a practic standpoint. R. Beeuwkes, electrical eng neer of the Chicago, Milwaukee & Paul RR., will act with Mr. Kerr on th committee, and the additional membe will be from other power companies, man facturers and banking institutions, so th every phase of this great subject will intelligently handled in the report of t committee which will be submitted at t Pasadena, California, convention, May to 21, 1920.

Joseph G. Worker, for many years ma ager of the Stoker Division, Westinghou Electric and Manufacturing Co., will, Jan. 1, 1920, assume the duties of gene manager of the Phoenix Manufacturing Co., Eau Claire, Wis., having general supervision of sales, engineering and production. The Phoenix Manufacturing Co. was established in 1861 as a partnership, and incorporated in 1875. It manufactures high-class machine tools, sawmill machinery, tractors and other machinery. In 1905 Mr. Worker left Deere & Co., manufacturers of agricultural implements, and entered the employ of the Westinghouse Machine Co. as stoker erector. In February, 1906, he was transferred to the New York office as assistant district stoker superintendent. In May, 1907, he left the Westinghouse Machine Co., entering the employ of the Calumet Steel Co., to assist the general superintendent in the construction of a steel rolling mill. Jan. 1, 1908, after the above mill was completed, he left the employ of the Calumet Steel Co. and reëntered the employ of the Westinghouse Machine Co. as assistant supervising engineer of the stoker department. In August, 1910, he was appointed engineer, stoker department, for the Western District. Aug. 1, 1915, he was appointed manager of stoker section, power department, Westinghouse Electric and Manufacturing Co.

Engineering Affairs

The American Society of Mechanical Engineers will hold its next meeting at St. Louis, Mo., May 24-27 inclusive.

The New England Water Works Association will hold a meeting on Dec. 10 at the Hotel Brunswick, Boston, Mass.

The American Electric Railway Association will hold its mid-year meeting and dinner at the Hotel Hollenden, Cleveland, Ohio, Jan. 8. An attractive program is being arranged.

The American Association for the Advancement of Science will hold its forty-second meeting at St. Louis, Mo., Dec. 29-Jan. 3, with headquarters at the Soldan High School.

The Association of Iron and Steel Electrical Engineers, Philadelphia Section, will hold a meeting on Jan. 3, 1920. J. D. Wright, electrical engineer, power and mining division, engineering department, General Electric Co., will present a paper on "Electric Mill Drives."

The American Society of Mechanical Engineers, Boston Section, held a joint session with the Boston Section of the American Institute of Electrical Engineers on Dec. 16, when inspection of the Watertown Arsenal and the laboratory of the new Harvard Engineering school was made. Prof. Albert Sauveur, of Harvard University, spoke after the dinner at the Harvard Union, on "Metallography and Heat Treatment of Metals."

The American Society of Heating and Ventilating Engineers will hold its annual meeting in New York City, Jan. 27-29. Among the many interesting papers to be presented are the following: "Oil as a Fuel for Boilers and Furnaces," by H. H. Fleming, engineer of the fuel-oil department of the Standard Oil Co.; "Relation of Boiler-Heating Surface Area to Boiler Capacity," by P. J. Dougherty; "Color Schemes for Distinguishing Plant Piping," by H. L. Wilkinson.

The National Electric Light Association, Inductive Interference Committee, held its second meeting in Denver, Colo., Dec. 1-3, 1919. The meeting was well attended by members from all parts of the country. Some of the sessions were devoted to a continuation of the attention given at the Chicago meeting in September to organizing for the work in hand, including the establishing of a centralized agency to assist power companies to effective coöperative efforts and a better understanding in meeting the difficult problems of the inductive interference situation, a situation continually increasing in proportion with the rapid multiplying of power and communication circuits. Other sessions were given to the subcommittee work in analyzing and compiling information gathered pertinent to the situation and to consideration of requests from several localities for advice in meeting specific and active inductive interference problems.

Miscellaneous News

A Refrigerator Fleet is to be formed in Italy by requisitioning six German refrigerator steamers and transforming three Italian steamers temporarily into refrigerators. These nine vessels will be capable of transporting 17,000 tons of frozen meat.

The Franklin Institute, acting through its Committee on Science and the Arts, has awarded its Edward Longstreth Medal of Merit to John Walter Ledoux of Swarthmore, Pa., for the Simplex Venturi meter manufactured by the Simplex Valve and Meter Co., of Philadelphia.

The National Electric Light Association's Overhead Systems Committee is planning in its 1920 report to bring to the attention of the industry any new devices that, in the committee's opinion, would be useful in line construction or line maintenance work. In order to make the report as useful as possible, the committee would be glad to get in touch with any manufacturers making such tools or devices for use in overhead line work. It is not the committee's plan to include in its report anything whatever regarding the various lines of standard fixtures that are on the market, but to call attention to special articles that might prove of particular value to operating companies. Any data regarding such items should be sent to W. K. Vanderpoel, Chairman of the Overhead Systems Committee, at 80 Park Place, Newark, N. J.

Vibration of buildings is an interesting subject to the power-plant engineer. It is one of the practical difficulties that confront him in his everyday work and one upon which little published information is available. The Aberthaw Construction Co., of 27 School St., Boston, started an investigation of the subject, and published a preliminary report in 1916, but our entry into the war put a summary stop to the work. It has now been taken up again, and the company would welcome any contribution to the knowledge upon the subject, or any account of experiences which might aid in its investigation and solution. We are sure that our readers will be glad to place any information or suggestions at their command in the possession of the company and shall look forward with interest to see what the investigation may develop.

Business Items

The Arrow Engineering Co., of Chicago, will hereafter represent the National Pipe Bending Co., of New Haven.

The Erie Engine Works, Erie, Penn., announces the opening of a new Philadelphia sales office at 1304 Pennsylvania Building, with Otto C. Reymann in charge.

The Sterling Blower Co., Hartford, Conn., has opened an office in Philadelphia to take care of its growing business in that territory.

The American Fabrics Co., Bridgeport, Conn., announces that it has acquired the entire business heretofore conducted under the name of International Textile, Inc.

The Link-Belt Co., on account of its growing business, is contemplating an extension to its Belmont factory, and in time completing its new furnace buildings, Nos. 7 and 8.

The Van Dorn Electric Tool Co., Cleveland, Ohio, on account of its growing business, is having a new four-story building put up, with 30,000 additional feet of floor space.

Mono Corporation of America, Buffalo, N. Y., has recently incorporated, and has engaged space for offices, stockrooms, service department and laboratory, on the fifth floor of the Coal and Iron Exchange, at 257 Washington St., Buffalo, N. Y.

The Bound Brook (N. J.) Oil-less Bearing Co. has completed another new building as an addition to its plant. A new power plant has also been added as well as a new office building. The new building adjoins the foundry which was completed in 1917.

The Black & Decker Manufacturing Co., Baltimore, Md., has opened an additional office on the Pacific Coast, at 201 Maynard Building, Seattle, Wash., in charge of A. E. Nordwall, who will have charge of the distribution of the company's products in the State of Washington, working under the direction of the main Pacific Coast office, 918 Hearst Building, San Francisco.

The Petroleum Heating and Power Co has been organized, with $2,000,000 capital, by Boston and New York men, to take over the Fess Rotary Oil Burner, Inc. The company is engaged in the installation of burners and supplying of fuel oil by means of a fleet of motor trucks, each with a capacity equivalent to ten tons of coal, and covering Boston and Providence suburbs. It is planned to start similar services at New York, Philadelphia, Washington and other cities along the Atlantic seaboard.

Jenkins Bros., it is announced, will, in the near future, increase their manufacturing facilities by owning and operating a plant in Bridgeport, Conn. This plant will be devoted entirely to the manufacture of the Jenkins valve. To take care of the company's rapidly increasing business abroad, the Canadian branch, Jenkins Bros., Ltd., Montreal, has recently completed alterations and additions to its brass valve department and now has in course of construction a new 192 x 80 ft. iron valve foundry.

The Hays School of Combustion announces that W. L. Abbott, chief operating engineer of the Commonwealth Edison Co., Chicago, has become associated with the course in combustion engineering as reviewing and advisory editor. Mr. Abbott's position in the power-plant operating field will add weight and authority along operating lines to the teachings of the institution and will, round out the faculty, which includes, besides Joseph W. Hays, the author of the course, the following well-known men: Joseph Harrington, Fred R. Low, David Moffat Myers, S W. Parr and Arthur L. Rice.

The Hooven, Owens, Rentschler Co., Hamilton, Ohio, has opened two new offices and has made some changes in the personnel of its other offices as follows: A new office has been opened in Philadelphia at 2129 Land Title Building, and C. M. Decker, formerly with R. D. Wood Co. has been made manager. A new office has also been opened at Richmond, Va., with E. H. Fairchild, formerly of the C. & G Cooper Co., in charge. E. S. Cooley, formerly with the Fall River Ship Building Co., is now connected with the New York office of the company. Henry E. Balsley, formerly with the American Bridge Co., has been made manager of the Chicago office. R. G. Holman, formerly with the General Electric Co., centrifugal department, is now associated with the company in charge of all blowing engines.

Trade Catalogs

The Star Brass Works, Chicago, Ill., has issued a new 12-page bulletin, No. 6, pertaining to its line of small steam- and water-jet apparatus, small steam-jet pumps, etc., fully illustrated; valuable engineering data also included. Copy free upon request.

J. E. Rhoads & Sons, Philadelphia, Penn., has issued a new edition of its "Belt User's Book," which contains some valuable information, rules and suggestions to users of leather belting. A horsepower table for leather belting is also given. The book is a distinct improvement on the one previously issued and may be had free upon request.

The Under-Feed Stoker Co. of America, Detroit, Mich., has issued a 31-page booklet on "Coal." This gives very complete information covering proximate and ultimate analysis of coals from every mining section in the United States, as well as other valuable information on coal and coal consumption. Copies of the booklet may be had free upon request.

Ont., Toronto—A. D. Gorrie & Co., Ltd. has awarded the contract for the construction of a 4 story, 75 x 115 ft. garage on Victoria St., to T. E. Essery, Confederation Life Bldg. A heating system will be installed in same. Total estimated cost. $125,000.

The Nelson Valve Co., Philadelphia, Penn., has issued a 156-page leather-bound catalog and price list, No. 10, on "Nelson Valves." This catalog is fully illustrated and describes in detail bronze, iron, and steel valves in gate, globe, check and non-return patterns, including types for practically every class of service in power plant work, industrial establishments and large building construction.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$8.20@$8.86
Stove	8.45@ 9.05
Chestnut	8.55@ 9.05
Pea	7.05@ 7.40
Buckwheat	3.60@ 3.80
Rice	2.30@ 2.60
Barley	1.25

Bituminous

	Clearfields	Cambrias and Somersets
f.o.b. mines, net tons	$2.85@$3.35	$3.15@$3.60
F.o.b. Philadelphia, gross tons	5.05@ 5.60	5.35@ 5.90
F.o.b. New York, gross tons	5.40@ 5.95	5.75@ 6.25
Alongside Boston (water coal), gross tons	7.00@ 7.75	7.60@ 8.90

Pocahontas and New River are practically off the market for coastwise shipment, but are quoted at $6.25@$7.00.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports are as follows:

Anthracite

	Company Coal
Broken	$7.80@$8.25
Egg	8.20@ 8.85
Stove	8.45@ 9.05
Chestnut	8.65@ 9.05
Pea	7.05@ 7.40
Buckwheat	6.15
Rice	4.50
Barley	4.85
Boiler	4.85

Bituminous

	Spot
South Fork (best)	$3.25@$3.60
Cambria (best)	3.00@ 3.25
Cambria (ordinary)	2.80@ 2.90
Clearfield (best)	3.00@ 3.25
Clearfield (ordinary)	2.80@ 2.90
Reynoldsville	2.85@ 2.90
Quemahoning	3.25@ 3.50
Somerset (medium)	3.00@ 3.25
Somerset (poor)	2.60@ 2.75
Western Maryland	2.50@ 2.75
Fairmont	2.25@ 2.50
Latrobe	2.60@ 2.90
Greensburg	2.75@ 3.00
Westmoreland ¾ in.	3.40@ 3.60
Westmoreland run-of-mine	2.75@ 3.00

PHILADELPHIA—Anthracite prices are practically the same as those listed above for New York. Bituminous coal prices vary according to district from which they are mined. For ordinary slack the price is $2.45@$2.65; lump, $3.00@$3.35.

BUFFALO—

Anthracite

	On Cars, Gross Ton	At Curb, Net Ton
Grate	$8.35	$10.80
Egg	8.80	10.65
Stove	9.00	10.95
Chestnut	9.10	10.85
Pea	7.75	9.30
Buckwheat	5.75	7.75

Bituminous

Allegheny Valley	$4.80
Pittsburgh	4.65
No. 8 Lump	4.85
Mine Run	4.80
Slack	4.10
Smokeless	4.60
Pennsylvania Smithing	5.70

CLEVELAND—Prices of coal per net ton delivered in Cleveland are:

Anthracite

Egg	$11.75@$11.90
Chestnut	12.00@ 12.05
Grate	11.75@ 11.90
Stove	11.90@ 12.10

Pocahontas

Mine-run	$7.50

Domestic Bituminous

West Virginia splint	$6.50
No. 8 Pittsburgh	$5.60@ 6.00
Massillon lump	6.25@ 6.60
Coshocton lump	7.15

Steam Coal

No. 8 slack	$5.25@$5.50
No. 8 slack	5.10@ 5.50
Youghiogheny slack	6.25@ 6.55
No. 8 ¾ in.	5.70@ 6.00
No. 6 mine-run	5.25@ 5.50
No. 8 mine-run	5.75

Only coal available is mine-run Pocahontas.

MIDDLE WEST—Chicago quotations, F.o.b. cars at mine:

	Springfield Carterville Williamson Franklin Saline Harrisburg	Fulton Peoria	Grundy La Salle Bureau Will
Lump	$2.55@$2.70	$2.95@$3.10	$3.25@$3.40
Washed	2.75@ 2.90	....	3.45@ 3.60
Mine Run	2.35@ 2.50	2.75@ 2.90	3.00@ 3.15
Screenings	2.05@ 2.20	2.35@ 2.50	2.75@ 2.90

New Construction

PROPOSED WORK

Conn., Bridgeport—The United Illuminating Co., 84 Temple St., New Haven, plans to construct a power station on Congress St., to develop 30,000 kw. (ultimately 100,000 kw.), six battery, 750 h.p. B. & W. boilers, 200% rating, and three 10,000 kw. turbines (probably G. E.) will be installed in same. Total estimated cost, $1,500,000. Westcott & Mapes, 207 Orange St., New Haven, Engrs.

Conn., Bristol—The Board of Education is having plans prepared for the construction of a 3 story high school. A steam heating system will be installed in same. Total estimated cost, $600,000. Wilson Potter, 22 East 17th St., New York City, Arch. and Engr.

Conn., Meriden—The Y. M. C. A., 21-23 Colony St., will soon award the contract for the construction of a 4 story, 138 x 138 ft. building on West Main St. A Kriebel vapor vacuum system will be installed in same. Total estimated cost, $360,000. Jallade, Lindsay & Warren, 37 Liberty St., New York City, Archs.

Conn., South Norwalk—J. C. Schaeffler, Arch. and Engr., 40 West 32nd St., New York City, is preparing plans for the construction of a factory. A steam heating system will be installed in same. Total estimated cost, $150,000. Owner's name withheld.

Conn., Waterbury—Cross & Cross, Archs., 651 5th Ave., New York City, will soon award the contract for the construction of an isolation hospital on Watertown Ave., for the city. A steam heating system will be installed in same. Total estimated cost, $200,000.

Conn., Windsor—The General Electric Co. plans to build an addition to its plant, here. Estimated cost, $75,000. A. A. Bailey, Gen. Mgr.

N. Y., Buffalo—The Daily Bread Co. is having plans prepared for the construction of a 3 story bakery. A steam heating system will be installed in same. Total estimated cost, $200,000. L. S. Beardsley, 40 West 32nd St., New York City, Arch. and Engr.

N. Y., Churchville—Alderman, Fairchild & Co., 367 Orchard St., Rochester, manufacturers of paper boxes, plan to build a 1 story, 63 x 233 ft. building on East Buffalo St. An electric power plant and transmission machinery will be installed in same. Total estimated cost, $95,000.

N. Y., Fulton—The Board of Education plans to build a 2 story high school. A steam heating system will be installed in same. Total estimated cost, $225,000. Wilson Potter, 22 East 17th St., New York City, Arch. and Engr.

N. Y., Lake Placid—The Stevens Hotel Co. plans to construct a fireproof addition. A steam heating system will be installed in same. Total estimated cost, $200,000.

N. Y., New York—G. A. and H. Boehm, 7 West 42nd St., is in the market for oil burning devices for low pressure steam plants.

N. Y., New York—Euvrard, Sambach & Euvrard, Archs. and Engrs., 29 Cleveland Pl., are preparing plans for the construction of a 7 story loft building at 48-50 West 36th St. A steam heating system will be installed in same. Total estimated cost, $400,000. Owner's name withheld.

N. Y., New York—The International Sporting Club, c/o W. H. Gompert, Arch. and Engr., 171 Madison Ave., is having plans prepared for the construction of a 9 story club house on 49th St. and Lexington Ave. A steam heating system will be installed in same. Total estimated cost, $600,000.

N. Y., New York—A. E. Lefcourt & Co., 140 Madison Ave., is having plans prepared for the construction of a 12 story, 100 x 200 ft. office and loft building at 223 West 38th St. A steam heating system will be installed in same. George and Edward Blum, 505 5th Ave., Archs. and Engrs.

N. Y., New York—The New Pine St. Realty Co., 31-33 Pine St., will build a 4 story bank and office building. A steam heating system will be installed in same. Total estimated cost, $200,000. Work will be done by day labor.

N. Y., New York—J. C. Schaeffler, Arcl
and Engr., 40 West 32nd St., is preparin
plans for the construction of a loft build
ing at 539-549 Broome St. A steam heat
ing system will be installed in same. To
tal estimated cost, $150,000. Owner's nam
withheld.

N. Y., Ontario—The Ontario Storag
Corporation plans to construct a col
storage plant and install ice-making ma
chinery in same. Total estimated cos
$150,000. J. S. Albright, Pres.

N. Y., Peekskill—The Baron de Hirsc
School, 222 East 64th St., New York City
is having plans prepared for the construc
tion of a 1 story power house. Estimate
cost, $150,000. E. I. Shire, 373 4th Ave
New York City, Engr.

N. J., Hoboken—H. R. Mallinson & Co
Woolsley Ave., Long Island City, is hav
ing plans prepared for the construction
a silk mill. A steam heating system wi
be installed in same. Total estimate
cost, $200,000. Lockwood, Green & Co., 1
Park Ave., New York City, Archs. an
Engrs.

Pa., Hazelton—The citizens have ap
proved a loan of $250,000 for the comple
tion of two school buildings. Contrac
will be let for installing heating, lightin
and ventilating systems in same.

Pa., Philadelphia—The Department
Health & Charities, City Hall, has awarde
the contract for installing heating syste
in the proposed 2 and 3 story additio
to hospital buildings, on Luzerne and 2r
Sts., to Charles E. Munday & Co. Tot
estimated cost, $200,000.

Pa., Philadelphia—Paul Monaghan, Arcl
1218 Chestnut St., will soon award tl
contract for the construction of a 3 stor
49 x 125 ft. high school on 49th and Ches
nut Sts., for the West Philadelphia Catl
olic High School, 49th and Chestnut St
A steam heating system will be install
in same.

Pa., Philadelphia—Frank V. Nickel
Arch., 4400 Manayunk St., will soon awa
the contract for the construction of a
story, 80 x 225 ft. factory on Boynton ar
Chelton Aves. A steam heating syste
will be installed in same. Total est
mated cost, $90,000. Owner's name witl
held.

Pa., Scranton—The United Service C
Scranton Life Bldg., is in the market f
boiler room equipment and accessories.

Pa., Philadelphia—The Board of Educ
tion, Keystone Bldg., plans to build two
story, 115 x 165 ft. grade schools; one
70th and Buist St. and the other on 9
and Oregon St. Steam heating syster
will be installed in same. Total estimat
cost, between $880,000 and $1,000,000.

Pa., Wilkes Barre—The Goldsmith Si
Co. plans to construct a 3 story, 300 x 4
ft. silk mill on Blackman St. A stea
heating system and boiler plant will be i
stalled in same. Total estimated co
$500,000.

Pa., Wilkes-Barre—The Kitsee Batte
Co., 62 North Main St., is having pla
prepared for the construction of a 3 stor
80 x 150 ft. storage battery factory
North Main St. A steam heating syste
will be installed in same. Total estimat
cost, $100,000.

Del., Middletown—W. E. Hance, Arcl
1619 Chestnut St., will receive bids abo
February 1 for the construction of a
story, 100 x 140 ft. school for the Boa
of Education. A steam heating syste
will be installed in same. Total estimat
cost, $100,000.

N. C., Statesville—The Statesville Ho
Co. plans to construct a 5 story, 40 x 1
ft. hotel. A low pressure steam heati
system will be installed in same. Tot
estimated cost, $150,000. Louis H. Asbur
Realty Bldg., Charlotte, Arch.

S. C., Charleston—The Bureau of Yar
& Docks, Navy Department, Washingto
D. C., will soon award the contract f
the installation of a heating system
the torpedo storehouse building No. 1
and for the construction of a boiler hou
addition to the same, at the Naval Ar
munition Depot, here.

La., Monroe—The city has voted $1,45
000 bonds, part of which will be used f
the construction of an electric pow
plant, including turbo-generators, 1000 k
capacity, with condensers, superheaters f
present boilers, resetting present boile
and a brick and concrete chimney; al
improvements to waterworks, includi
centrifugal raw water pumps, servi
pumps with a 4,000,000 gal. capacity, e

Tenn., Memphis—The Sugar Products ;o., 16 Exchange Pl., New York City, plans o construct a molasses storage building o house a 500,000 gal. tank, power plant, umping and transferring equipment. Esimated cost, $50,000.

Ohio, Cincinnati—The city plans to intall new boilers in the Main River pumpng stations and boiler equipment in the Vestern Hills Station. Total estimated ost, $380,000. Frank Krug, City Hall, Engr.

Ohio, Cleveland—The Grace Hospital Association, 2307 West 14th St., is preparng plans for the construction of a 5 story, 00 x 280 ft. hospital on West 14th St. A team power plant, consisting of one 300 .p. boiler with stokers, feed water pumps, lowers, oil separators, air compressors, tc., will be installed in same. Total estiated cost, $500,000. W. S. Longee, Marhall Bldg., Arch.

Ohio, Dayton—The Dayton Power & ight Co., Home Telephone Bldg., plans double the capacity of its plant at tillers Ford, near here. The total caacity of the plant, when additional equipent is installed, will be 60,000 h.p. O. H. Iutchings, Gen. Mgr. Total estimated ost, $800,000.

Ohio, Dayton—The Jefferson Main St. larket Co. plans to build a 4 story, 50 x 0 ft. market building on South Main St. wo elevators and a cold sorage plant will e installed in same. Total estimated ost, $500,000. Joseph Lowes, Schwind ldg., Arch.

Ohio, Dayton—The Peckham Coal & Ice o., Daller and Chapel Sts., plans to build 2 story, 100 x 110 ft., 75 ton ice manucturing plant, on Linden Ave. Estimated ost, $70,000.

Ohio, East Liverpool—The Ohio River ower Co. is having plans prepared for e construction of a transformer sub-staon with connecting buildings. Total esmated cost, $600,000.

Ind., Indianapolis—George C. Hitt, Busiess Director, will soon award the conact for the construction of a 3 story rsenal Technical High School for the oard of School Commissioners, Meridian d Ohio Sts. A steam heating system ill be installed in same. Total estimated st, $700,000. Snider & Rotz, Merchants ank Bldg., Engrs. Vonnegut, Bohn & iller, Indiana Trust Bldg., Archs.

Ind., Princeton—The Commissioners of e Patoka Wabash Drainage and Levee istrict have retained T. W. Jacob, Boaten's Bank Bldg., St. Louis, Mo., to make vestigations and submit a report for the nstruction of a 38 mile levee with flood tes and pumping station.

Mich., Adrian—The State Industrial ome for Girls engaged Robert Ernst, ngr., 35 Bagg St., Detroit, to submit preninary estimates for installation of heatg equipment in plant to heat adminisation building and surrounding buildgs.

Mich., Detroit—I. Applebaum, 2023 Dime ink Bldg., engaged Alvin F. Harley, ch., Kresge Bldg., to prepare plans for e construction of a 3 story, 76 x 180 ft. ctory on Russell St. near Medbury St. steam heating system and electric mors for power will be installed in same. tal estimated cost, $100,000.

Mich., Detroit—The Board of Education, Broadway, received bids for the instalion of a heating, ventilating and plumbg system in the proposed 150 x 211 ft. hool on Maplewood and Spokane Aves., m Irvine & Meier, 2289 Woodward Ave., .682; J. W. Partlan, 51 Park Place, .346; W. J. Rewoldt, 506 Owen Bldg., .860.

Mich., Detroit—The Board of Education, Broadway, is having plans prepared for e construction of a 3 story, 100 x 250 ft. hool at Goldberg Athletic Field. A enum steam heating system, consisting boiler, fans and pump, will be installed same. Total estimated cost, $400,000. alcolmson, Higginbotham & Palmer, 405 ffat Bldg., Archs.

Mich., Detroit—The city received bids the construction of 7 mi. Rd. sewer d a temporary pumping station, with ctrically operated pumps, from C. A. ndyside, 833 Lothrop Ave., $26,600; wer Plant Supply Co., Chamber of Comrce, $29,980.

Mich., Detroit—Louis Kamper, Arch., ok Bldg., is preparing plans for the conuction of a 2 story, 58 x 72 ft. bank ilding on Gratiot Ave. near Jos. Campau Ave. A steam heating system will be installed in same. Total estimated cost, $100,000. Owner's name withheld.

Mich., Detroit—The Nativity Church, c/o Rev. F. Heidenich, McClellan Ave., is having plans prepared for the construction of a 2 story church on McClellan Ave. near Lamb Ave. A steam heating system will be installed in same. Total estimated cost, $175,000. Van Leyden, Schilling & Keough, Union Trust Bldg., Archs. and Engrs.

Mich., Flint—Van Leyen, Schilling & Keough, Archs. and Engrs., 201 Walsh Bldg., plan to construct a 1 story, 30 x 248 ft. coal storage building on Industrial Ave. Electric motors will be installed in same. Total estimated cost, $35,000. Owner's name withheld.

Mich., Ford City (Wyandotte P. O.)—The Board of Education has engaged J. G. Kastler & Co., Arch., 523 Chamber of Commerce, Detroit, to prepare plans for the construction of a 2 story school on Main St. Steam heating equipment will be installed in same. Total estimated cost, $150,000.

Mich., Grand Rapids—Our Lady of Sorrows Parish, c/o Rev. Salvatore Cianci, engaged Harry L. Mead, Arch., Houseman Bldg., to prepare plans for the construction of a 2 story church and school. A steam heating syetem will be installed in same. Total estimated cost, $175,000.

Mich., Jackson—The First Methodist Episcopal Church retained W. E. N. Hunter, Arch., 1306 Chamber of Commerce, Detroit, to prepare plans for the construction of a 2 story community house. Steam heating equipment will be installed in same. Total estimated cost, $200,000.

Ill., Chicago—The Hollander Fireproof Storage Co., 1616 Milwaukee Ave., is having plans prepared for the construction of a 7 story, 75 x 130 ft. storage warehouse on Lawrence and North Sawyer Aves. A steam heating system and refrigeration plant will be installed in same. Total estimated cost, $250,000. Moores & Dunford, 38 South Dearborn St., Engrs.

Wis., Milwaukee—W. S. Seaman Co., 480 Virginia St., has purchased a site and plans to build a 6 story, 100 x 400 ft. and 50 x 70 ft. factory on Port Washington Rd. Estimated cost, $500,000. A steam power plant will he erected.

Wis., Milwaukee—The A. O. Smith Corporation, 27th and Keefe Ave., has had plans prepared for the construction of a 2 and 6 story, 365 x 850 ft. factory. A steam heating system will be installed in same. Total estimated cost, $1,500,000. H. J. Esser, Camp Bldg., Arch and Engr.

Wis., Tomah—The Board of Education is having plans prepared for the construction of a 3 story, 50 x 60 ft. addition to high school and central heating plant. Plans include 700 ft. heating tunnel. Total estimated cost, $60,000. H. C. Haeuser, Colby-Abbot Bldg., Milwaukee, Arch. and Engr.

Minn., Coleraine—A. King, Secy. of the Board of Education, will receive bids in March for the construction of a 2 story; 150 x 270 ft. high school in the Canistes District. A steam heating and mechanical ventilating system will he installed in same. Total estimated cost, $500,000. W. T. Bray, Torrey Bldg., Duluth, Arch. and Engr.

Minn., Duluth—The Y. M. C. A., 3rd Ave., Duluth, will soon award the contract for the construction of a 3 story, 75 x 113 ft. building on Central Ave. A steam heating system will be installed in same. Total estimated cost, $100,000. B. C. Wade, Y. M. C. A. Bldg., Duluth, Secy. German & Jenssen, Exchange Bldg., Archs. and Engrs.

Minn., Ellsworth—The town is having plans prepared for new electric-light equipment. Estimated cost, $10,000. Druar & Smith, Globe Bldg., St. Paul, Engrs.

Minn., Hastings—The State Board of Control, Capitol, St. Paul, will soon award the contract for the construction of a 1 story, 45 x 140 ft. power plant and is in the market for equipment for same. Total estimated cost, $125,000. C. L. Pillsbury Co., Metropolitan Bank Bldg., Minneapolis, Engr.

Minn., Hopkins—The village plans to construct a well about 750 ft. deep, and install pumping machinery. Estimated cost, $20,000. J. W. Schaffer, Engr.

Minn., New Ulm—The Eagle Rolling Mill Co. will soon award the contract for furnishing rolling equipment, including boilers, crane and coal handler. Estimated cost, $35,000. C. L. Pillsbury Co., Metropolitan Life Bldg., Minneapolis, Engr.

Minn., Minneapolis—L. S. Donaldson Co., 601 Nicollet Ave., plans to construct a 6 story addition to its present department store on 7th St. and Marquette Ave. A steam heating system will be installed in same. Total estimated cost, $800,000. Graham, Anderson, Probst & White, 1417 East Jackson Blvd., Chicago, Archs.

Minn., Minneapolis—The Northwestern Glass Co., 219 2nd St., N., plans to construct a 4 story, 66 x 162 ft. factory addition on 2nd Ave. and 2nd St., N. A heating plant will be installed in same. Total estimated cost, $100,000. Bertrand & Chamberlain, Northwestern Bank Bldg., Archs.

Minn., Minneapolis—B. N. Schneider, Plymouth Bldg., is having plans prepared for the construction of a 3 story, 90 x 120 ft. office building on 8th and Marquette St. A steam heating system will be installed in same. Total estimated cost, $300,000. Kees & Colburn, Plymouth Bldg., Archs.

Minn., St. Paul—H. W. Austin, City Purchasing Agent, is in the market for air lift equipment, electric driven air compressor with motor and vertical steel air receiver for the Como Park pumping station.

Minn., St. Paul—The city is in the market for 2 direct connected motor driven centrifugal pumps for the Water Department.

Minn., St. Paul—The Minor Hotel Co., c/o Hotel Magee, Roberts and 4th Sts., will soon award the contract for the construction of a 12 story, 100 x 100 ft. hotel. A steam heating system will be installed in same. Total estimated cost, $1,500,000. Mark Fitzpatrick, 17 West 19th St., Arch.

Tex., Abilene—The American Public Service Corporation plans to construct a 3 story power plant to furnish power for the towns of Anson, Merkel, Stamford, Hamlin and Cisco, also an ice factory to have a daily capacity of 100 tons. Total estimated cost, $700,000. A. Hargrave, South Western Life Bldg., Gen. Mgr.

Tex., Fort Worth—The North Fort Worth Ice & Cold Storage Co., 1015 North Main St., is in the market for pumps, air compressor, etc.

Tex., Navasota—The Chamber of Commerce will soon award the contract for the construction of a 2 story, 86 x 110 ft. ice and cold storage building. Estimated cost, $75,000. L. M. Heurt, Secy.

Wyo., Cheyenne—A. A. Boernsen, Arch., will soon receive bids for the construction of a 4 story, 200 x 200 ft. hospital on 23rd and House St. for Laramie County. A power plant will be installed in same. Total estimated cost, $300,000.

Okla., Perry—F. F. Busch, City Clerk, will soon award the contract for the construction of a dam in connection with the waterworks and electric light improvements. Separate bids will be received for furnishing hydrants, valves, two oil engines, 200 h. p. boilers, 4 panel switchboard, generators, etc. Black & Veatch, Interstate Bldg., Kansas City, Mo., Engrs. Noted April 1.

Okla., Wilson—J. W. Ryder, Engr., 614 C St., N. W., Ardmore, is in the market for two 200 h.p. boliers and one 200 h.p. engine for the city.

Ariz., Jerome—Lescher & Kibbey, Archs., Bank of Arizona Bldg., Phoenix, will soon receive bids for the construction of a 2 story, 40 x 130 ft. hospital, for the United Verde Extension Mining Co. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ariz., Nogales—The city plans an election to vote on $135,000 bonds to lay 14 in. steel water main, $37,000 to install pumping units and $15,000 to enlarge and repair reservoir.

Wash., Seattle—The Puget Sound Navy Yard plans to install exhaust fan, 11,000 cu. ft. of air per minute against static head of 6 inches of water when operating 1200 r.p.m.; also one motor driven air compressor set. S. E. Barber, c/o Puget Sound Navy Yard, Supply Officer.

Ore., Grants Pass—Grants Pass Irrigation Co. plans to install an 18 in. centrifugal pump in ditch 33 ft. above sea level, driven by 125 h.p. electric motor. G. A. Hamilton, Secy.

Ore., Warrenton—The city voted $500,000 bonds at recent election to etxend and improve the harbor. Project will include the purchase of 100 acres of land on the Columbia and Shipanon Rivers, for the erection of piers and docks, also installation of cranes and necessary apparatus for speedy cargo handling. J. Evenden, Aud.

Cal., Blythe—The City Council will soon receive bids for the construction of a well, 50,000 gal. tank on an 80 ft. tower, 400 gal. per minute pumping plant, etc. Bonds amounting to $36,000 have been sold for the project. Olmsted & Gillelen, 1112 Hollingsworth Bldg., Los Angeles, Engrs.

Cal., Oakland—The Board of Supervisors of Alameda County will soon award the contract for the construction of a 4 story hospital on 14th Ave. and Vallecito Pl. A vacuum steam heating system and electric power system will be installed in same. Total estimated cost, $535,000. Henry H. Meyers, 1201 Kohl Bldg., San Francisco, Arch.

Cal., Santa Barbara—St. Francis Hospital, 6 Arrellage St., plans to build a 3 story, 200 ft. hospital, with two 2 story wings. A steam heating system will be installed in same. Total estimated cost, $175,000.

Cal., Yucaipa—The Redlands Yucaipa Land Co. will construct a water system in the Yucaipa Valley, consisting of several pumping plants, steel pipe lines and reservoirs. Total estimated cost, $100,000.

Ont., Holland Landing—The Township of Guillumbury has appointed E. A. James Co., Ltd., Engr., 36 Toronto St., Toronto, to prepare premliminary plans and surveys and submit estimates on the reclamation of 10,000 acres of a total of 80,000 acres of swamp land. Project will include low lift pumps, etc. Total estimated cost between $50,000 and $100,000.

Ont., Milverton—The town appointed E. A. James Co., Ltd., Engr., 36 Toronto St., Toronto, to prepare prelminiary plans and surveys and submit estimate of cost, for the construction of a distribution system and deep well pumps, pumphouse, water tower, etc. A centrifugal pump to deliver about 200 g.p.m. will be installed in same. Total estimated cost, $80,000.

Ont., Richmond Hill—The town engaged E. A. James Co., Ltd., Engr., 36 Toronto St., Toronto, to prepare prelminiary plans and submit estimates for the construction of a natural reservoir, pumphouse and a 7,500 gallon capacity elevated steel tank, also for furnishing duplex electric and gasolene turbine pumps with a capacity of 200 gallons per minute each, rapid sand filters, hydrants, valves, etc. Total estimated cost, $80,000.

Ont., Beaverton—The town has appointed James, Loudon & Hertzberg, Engrs., 36 Toronto St., Toronto, to make preliminary report on waterworks system. Plans include pump house, turbine pump, etc. Total estimated cost, $50,000.

Ont., Fergus—J. Alpaugh & Son have purchased a site and are preparing plans for the construction of a modern marble works plant. The owners plan to install a power plant in same. Estimated cost, $25,000.

Ont., Kitchener—F. McCutcheon, Star Theater, has purchased a site and plans to construct a 1 story, 80 x 100 ft. theater. A vacuum steam heating system with modern ventilating and cooling systems will be installed in same. Total estimated cost, $150,000.

Ont., Seaforth—The city retained James, Loudon & Hertzberg, Engrs., 36 Toronto St., Toronto, to prepare plans and estimates for the construction of a waterworks system. Plans include a pumphouse, centrifugal pumps, etc. Total estimated cost, $100,000.

Ont., Yorktown—J. & J. J. Allen, Richmond and Victoria St., Toronto, plan to construct a 2 story, 100 x 150 ft. theater and office building. A steam heating system and blower system will be installed in same. Total estimated cost, $125,000. C. Howard Crane, 2325 Dime Bank Bldg., Detroit, Arch.

CONTRACTS AWARDED

Mass., Boston—The First National Bank, 70 Federal St., has awarded the contract for the construction of a 108 x 171 ft. bank and office building on Milk St., to Stone & Webster Engineering Corporation, 147 Milk St. A steam heating system will be installed in same. Total estimated cost, $2,000,000.

Mass., Cambridge—The Whittemore Brothers Corporation has awarded the contract for the construction of a 3 story, 43 x 63 ft. storehouse on Albany St., to the Evatt Construction Co., 161 Devonshire St., Boston. A steam heating system will be installed in same. Total estimated cost, $150,000.

Mass., Cambridge—George H. Dyer Co., 155 Brookline St., has awarded the contract for the construction of a 2 story, 40 x 100 ft. addition to its factory, to F. J. Van Etten, 153 Milk St., Boston. The present heating system will be revamped and the company expects to spend over $10,000 for equipment in the spring.

Mass., Lynn—Hilliard & Merrill, 83 South St., Boston, have awarded the contract for the construction of a 5 story, 50 x 500 ft. warehouse on Eastern Ave., to W. M. Bailey Co., 88 Broad St., Boston. A steam heating system will be installed in same.

Mass., New Bedford—The New Bedford Hotel Co., Pleasant St., has awarded the contract for the construction of a 9 story hotel on Middle, Pleasant, High and Foster Sts. to the Longacre Construction Co., 185 Madison Ave., New York City. A hot water heating system will be installed in same. Total estimated cost, $1,000,000.

Mass., New Bedford—A. A. Spitz, Caesar Misch Bldg., Providence, R. I., has awarded the contract for the construction of a 3 story, 86 x 140 ft. theater on Elm St., to C. I. Bigney Construction Co., Inc., 898 Westminister, Providence. A steam heating system will be installed in same. Total estimated cost, $175,000.

Mass., Newton—The city has awarded the contract for the construction of a 2 story, 110 x 150 ft. school at Waban, to C. S. Cunningham & Sons Construction Co., 7 Water St., Boston. A steam heating system will be installed in same. Total estimated cost, $260,000.

Mass., South Boston—The Broadway Real Estate Trust Co. has awarded the contract for the construction of a theater and postoffice building to Fred T. Ley & Co., Inc., 499 Main St., Springfield. A steam heating system will be installed in same. Total estimated cost, $400,000.

R. I., Central Falls (Pawtucket P. O.)—The Fortuna Silk Mill, Clay St., has awarded the contract for the construction of a 4 story, 40 x 175 ft. silk mill addition, to the C. I. Bigney Construction Co., 898 Westminster St., Providence. A steam heating system will be installed in same. Total estimated cost, $100,000.

R. I., Providence—The Atlantic Tubing Co., 1756 Cranston St., has awarded the contract for the construction of a 2 story, 34 x 48 ft. boiler house on Cranston St., to C. I. Bigney Construction Co., 898 Westminster St.

Conn., Bridgeport—The American Fabrics Co., Connecticut Ave., has awarded the contract for the construction of a 2 story factory to the Aberthaw Construction Co., 27 School St., Boston, Mass. A steam heating system will be installed in same. Total estimated cost, $150,000. International Textile Co., lessee.

Conn., Bridgeport—Hincks Brothers & Co., 207 State St., has awarded the contract for the construction of a 1 and 3 story, 39 x 104 ft. business building on Main St. to Mark C. Treddenick Co., 1188 Main St. A steam heating system will be installed in same. Total estimated cost, $100,000.

Conn., Hartford—The Hanson Whitney Machine Co., Bartholemew Ave., has awarded the contract for the construction of a 4 story, 60 x 120 ft. factory, to the Portens Walker Co., 13 Forest St. A steam heating system will be installed in same. Total estimated cost, $100,000.

Conn., Mansfield—The State Board of Education, Hartford, has awarded the contract for the construction of 2 and 3 story institutional buildings at the State Training School here to H. Wales Lines Co., 13 State St., Meriden. A steam heating system will be installed in same. Total estimated cost, $300,000.

Conn., New Britain—The New Departure Manufacturing Co., 269 North Main St., manufacturers of ball bearings, has awarded the contract for the construction of a plant consisting of 11 buildings, including a 1 story, 50 x 92 ft. boiler house and a 2 story, 40 x 130 ft. transformer house at the main plant, and a 1 story, 45 x 60 ft. boiler house at the north plant, to the Turner Construction Co., 178 Tremont St., Boston, Mass.

Conn., New Haven—The Y. M. C. A., 152 Temple St., has awarded the contract for the construction of a gymnasium and club addition to Y. M. C. A. building, on Howe and Chapel Sts., to the Larkin-Carey Co., 166 Brewery St. A steam heating system will be installed in same. Total estimated cost, $150,000.

N. Y., Brooklyn—The American Machin Foundry Co., 55th and 56th Sts., betwee 1st and 2nd Aves., has awarded the contract for the construction of a 6 story 127 x 190 ft. factory addition on 55th St. to H. D. Best, 949 Broadway, New Yor City. A steam heating system will b installed in same.

N. Y., Little Falls—The Barnet Leathe Co., 598 East Mill St., has awarded th contract for the construction of a 1 story 40 x 50 ft. boiler house and a 1 story, 15 40 ft. pump room, to the Industrial Engineering Co., 30 Church St., New Yor City. Total estimated cost, $50,000.

N. Y., New York—The Amalgamate Centre, Inc., c/o G. A. and H. Boehm Archs., 7 West 42nd St., will build a story, 60 x 130 ft. club house on 2nd Ave and 11th St. A steam heating syste will be installed in same. Total estimated cost, $500,000. Work will be don by day labor.

N. Y., New York—The Fred F. Frenc Co., 299 Madison Ave., will build a 16 stor 50 x 75 ft. office building on Madison Ave and 41st St. A steam heating system wi be installed in same. Work will be don by day labor.

N. Y., New York—E. Margolies, 19 Eas 33rd St., will build a 16 story, 56 x 15 ft. office building at 309-311 5th Ave. steam heating system will be installed i same. Total estimated cost, $450,00 Work will be done by day labor.

N. Y., New York—The Monterey Hote Broadway and 95th St., will build a 62 100 ft. hotel. A steam heating system wi be installed in same. Work will be don by day labor.

N. Y., New York—B. S. Moss, 729 7t Ave., has awarded the contract for th construction of a theater on Tremont Ave to the Fleischman Construction Co., 5 7th Ave. A steam heating system will b installed in same. Total estimated cos $400,000.

N. Y., New York—Peck & Peck, 586 5t Ave., will build a 10 story office buildin A steam heating system will be installe in same. Total estimated cost, $200,00 Work will be done by day labor.

N. Y., New York—St. Judes Chape West 99th St., has awarded the contra for the construction of a 5 story, 25 x 1 ft. parish house addition, to J. E. Wallac 442 West 46th St. A steam heating system will be installed in same.

N. J., Atlantic City—Braustein & Blat 1420 Atlantic Ave., has awarded the contract for the construction of an 8 stor 110 x 150 ft. department store on Atlant and South Carolina Aves., to Warre Moore & Co., 13th and Market Sts., Philadelphia. A steam heating system will installed in same. Total estimated cos $500,000.

N. J., Bayonne—The Board of Directo of the City Hospital has awarded th contract for the construction of a 4 stor 25 x 63 ft. hospital addition and pow house on East 30th St., to the Frankli Rocks Co., 354 West 24th St., New Yo City. Total estimated cost, $150,000.

N. J., Union—The Consumers Ice C 320 Fulton St., has awarded the contra for the installation of a freezing tank, hoist crane and thawing apparatus, 2 ca fillers, 4 brine agitators and 4 moles, the Shipley Construction & Supply Co., Warren St., Brooklyn. Estimated cos $55,750.

Pa., Philadelphia—The Kensington Hygeia Ice Co., Trenton and Huntingd Aves., has awarded the contract for t construction of a freezing tank with a story, 30 x 30 ft., a 1 story, 31 x 100 f and a 1 story, 20 x 80 ft. additions, Philip Haibach Contracting Co., 1261 Nor 26th St. Estimated cost, $25,000.

Pa., Philadelphia—Sears, Roebuck & C Arthington and Homan Ave., Chicago, h awarded the contract for the constructi of a mail order plant, to consist of one tory, 300 x 442 ft. and one 6 story, 80 x 20 ft. buildings and power house, to Irvin & Leighton, 126 North 12th St. Steam heating systems will be installed in same. Total estimated cost, $4,500,000. Noted Sept. 30.

Pa., Philadelphia—H. O. Wilbur & Sons, Inc., 235 North 3rd St., has awarded the contract for the construction of a 7 story, 0 x 92 ft. power and warehouse on 3rd and Race St., to the Turner Construction Co., 1713 Sansom St. The first two stories will be used for the boiler room and power house and the upper stories for storage purposes.

Pa., Philadelphia—The Hulton Dyeing Co., 3819 Frankfort Ave., has awarded the contract for the construction of a 2 story, 2 x 400 ft. factory on Wheatsheaf and Canal St., to G. Crompton & Brothers, 614 Oakland St. A steam heating system will be installed in same. Total estimated cost, $120,000.

Pa., Philadelphia—The American Preserve Co., 946 Beach St., has awarded the contract for the construction of a 5 story, 0 x 250 ft. factory and a 1 story, 50 x 70 ft. boiler house, on 3rd and Lehigh St., to Cramp & Co., Denckla Bldg. A steam heating system will be installed in same. Total estimated cost, $400,000.

Pa., Wilkes-Barre—The Y. W. C. A., Franklin St., has awarded the contract for the construction of a 1 story, 32 x 46 ft. boiler house, at 38 North Main St., to M. Leach, Pennsylvania Ave. Total estimated cost, $150,000.

Md., Cumberland—The ..Cumberland Amusement Co. has awarded the contract for the construction of a 1 and 2 story, 80 x 138 ft. theater on Baltimore St. to G. A. Fuller Co., Munsey Bldg., Washington, D. C. A steam heating system will be installed in same. Total estimated cost, $150,000.

Md., Towson Heights (Towson P. O.)—lack & Decker Manufacturing Co., manufacturers of special machinery, 105-15 South Calvert St., Baltimore, has awarded the contract for the construction of a 2 story, 0 x 200 ft. addition to its plant here to ustin & Co., 1821 North 5th St., Philadelphia, Pa., and Cleveland, Ohio. A steam heating system will be installed in same. Total estimated cost, $100,000.

Va., Norfolk—The Virginia Ice & Freezing Co. has awarded the contract for the construction of a 3 story, 150 x 200 ft. ice plant, to the White Construction Co., Inc., 95 Madison Ave., New York City. Estimated cost, $500,000.

N. C., Wilmington—The city has awarded the contract for the construction of a 3 story school to the Liberty Engineering & Construction Co. A heating system will be installed in same. Total estimated cost, $312,000.

Ga., Bainbridge—The Bainbridge Power Co. has awarded the contract for the construction of a dam and power house on Spring Creek, near here, to A. Dallen 'Brien, New Orleans, La.

Ga., Macon—The Atlantic Coal & Ice Co., aterville Rd., has awarded the contract for the construction of five 1 story warehouses to the Foundation Co., 233 Broadway, New York City. A steam heating system will be installed in same. Total estimated cost, $250,000.

Ohio, Ashtabula—The city has engaged N. Case, former county engineer, to prepare plans for the construction of additions to the lighting plant. The first work will be the construction of a cooling tank. Estimated cost, $15,000. Work will be done by day labor.

Ohio, Columbus—John Immel & Sons Co., East Livingston Ave., has awarded the contract for the construction of a new plant on a 6 acre site at High St. and nis Ave., to Charles W. Schneider & Sons, Pennsylvania R. R., south of the Fair Grounds. The plant will consist of four buildings, including a 250 x 350 ft. main building, a 1 story, 40 x 60 ft. office building, a 1 story power plant and a dry kiln. Total estimated cost, $400,000.

Ohio, Norwalk—The Citizens National Bank has awarded the contract for the construction of a 5 story, 60 x 115 ft. bank and office building, to Mills & Millspaugh, East Long St., Columbus. The heating contract will be sub-let by the general contractor. Total estimated cost, $200,000.

Ind., Indianapolis—The Polar Ice & Fuel Co., 20th and Northwestern St., has awarded the contract for the construction of a story 47 x 90 ft. ice storage building on Western Ave. to W. P. Junglass, Indianapolis. Estimated cost, $50,000.

Mich., Alma—The Northern Wheel Co. has awarded the contract for the construction of a 2 story, 60 x 320 ft. factory to Henry H. Soule, Alma. A steam boiler, pump, etc., will be installed in same.

Mich., Detroit—The Anderson Electric Car Co., Milwaukee Junction, has awarded the contract for the construction of a 4 story, 100 x 187 ft. factory, on Alberle and Russell Sts. to H. G. Christman Co., 315 Stevens Bldg. A steam heating plant will be installed in same. Total estimated cost, $170,000.

Mich., Detroit—John J. Barlum, 3061 West Grand Blvd., has awarded the contract for the construction of a 10 story, 30 x 36 ft. hotel and commercial building on Farmer and John Rd. to Otto Miach, Chamber of Commerce. A central steam heating plant will be installed in same. Total estimated cost, $125,000.

Mich., Detroit—The Detroit Edison Co., David Whitney Bldg., has awarded the contract for the construction of a 10 story, 150 x 250 ft. service station on 2nd and Alexander Aves., to A. A. Albrecht Co., 1130 Penobscot Bldg. Boilers and general heating equipment will be installed in same.

Mich., Detroit—The Enterprise Foundry Co., Theodore and Beaufait Ave., has awarded the contract for the construction of a 1 story, 39 x 80 ft. power plant, to the E. D. Jackson Construction Co., Ford Bldg. Steam heating equipment will be installed in same. Total estimated cost, $10,000.

Mich., Detroit—The Freud Hotel Co., Hotel Addison, has awarded the contract for the construction of a 17 story, 100 x 100 ft. hotel on Witherell and Elizabeth Sts., to George A. Fuller Co., 540 Penobscot Bldg. Refrigerating equipment, etc., will be installed in same. Total estimated cost, $2,000,000.

Mich., Detroit—The General Carbonic Co., 542 5th Ave., New York City, has awarded the contract for the construction of a 1 story, 100 x 120 ft. manufacturing plant, a 40 x 50 ft. boiler house and a 25 x 30 ft. garage, to the Austin Co., 217 Broadway, New York City. A steam heating system will be installed in same. Total estimated cost, $75,000.

Mich., Detroit—Pittman & Dean Co., 203 Griswold St., has awarded the contract for the construction of a 2 story, 97 x 106 ft. artificial ice plant on Brush and Victor Sts., to Pine & Munnicke, 103 Marquette Bldg. Electric motors for power will be installed in same. Total estimated cost, $70,000.

Ill., Chicago—The Central Bag Manufacturing Co., 3622 Iron St., has awarded the contract for the construction of a 1 and 2 story, 330 x 400 ft. factory on Western Ave. and 60th St. to the Saleman Waterton Co., 343 South Dearborn St. A steam heating system will be installed in same. Total estimated cost, $350,000.

Ill., Chicago—The Central Manufacturing District, 38 South Dearborn St., has awarded the contract for the construction of a 6 story, 200 x 200 ft. warehouse on 39th and Winchester St. to the E. W. Sproul Co., 2001 West 39th St. A steam heating system will be installed in same. Total estimated cost, $800,000.

Ill., Chicago—The Chicago & Alton Railway Co., 608 South Dearborn St., has awarded the contract for the construction of a 1 story, 154 x 460 ft. freight house at 344 to 355 West Harrison St. to the Melton Stewart Nelson Co., 208 South La Salle St. A steam heating system will be installed in same. Total estimated cost, $1,000,000.

Ill., Chicago—The John Crerar Library, Marshall Field Bldg., has awarded the contract for the construction of a 15 story 80 x 80 ft. library and office building on Michigan Ave. and Randolph St. to G. A. Fuller Construction Co., 175 5th Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $1,250,000.

Ill., Chicago Heights—Carley & Hansen have awarded the contract for the construction of a 1 story, 75 x 125 theater to Engel Brothers, Chicago Heights. A steam heating system will be installed in same. Total estimated cost, $150,000.

Wis., Milwaukee—The Harley-Davidson Motor Co., 3732 Chestnut St., has awarded the contract for the concrete work for the proposed 6 story, 122 x 214 ft. shaped L factory addition on Chestnut St., to the Raulf Co., Patton Bldg. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ia., Mitchellville—The city has awarded the contract for the construction of a pumping station, power transmission line and wells, to the Pittsburg-Des Moines Steel Co., 9th and Tuttle St., Des Moines. Contract does not include the furnishing of pumps for same. Estimated cost, $26,000. J. A. Kelley, Clk.

Minn., Duluth—The Duluth Telephone Co., East 1st St., has awarded the contract for the construction of a 4 story. 50 x 140 ft. telephone exchange on 1st St.. E., to George H. Lounsberry, 322 East Superior St. A steam heating and mechanical ventilating system will be installed in same. Total estimated cost, $250,000.

Kan., Wichita—The Board of Education has awarded the contract for the installation of a steam heating system in the proposed 3 story, 99 x 248 ft. Roosevelt Interstate School, to the McMahon Co.. Kansas City, Mo., $82,500.

Mo., St. Louis—The Sugar Products Co., 16 Exchange Pl., New York City, has awarded the contract for equipping and installing a 500,000 gallon molasses storage tank, pumping station and equipment for transferring, also oil engine equipment, to P. A. Rohan, North First St. Total estimated cost, $30,000.

Tex., Breckenridge—The Texas Co., 17 Battery Pl., New York City, has awarded the contract for the construction of a steel compression plant and an absorption plant, to Westinghouse, Church, Kerr, Inc., 37 Wall St., New York City. A steam heating system will be installed in same. Total estimated cost, $150,000.

Tex., San Jose—The Stroud Manufacturing Association has awarded the contract for the construction of an auto factory. power plant, foundry and residences for employes to Bartlett & Ranney, San Antonio. Total estimated cost, $550,000.

Okla., Okmulgee—The city has awarded the contract for furnishing pumps in connection with waterworks system to the Merkle Machinery Co., 508 Interstate Bldg.. Kansas City, Mo.

Ariz., Phoenix—The Geronimo Hotel Co., c/o Postle & Fisher, Archs., 140 South Dearborn St., Chicago, has awarded the contract for the construction of an 8 story, 138 x 205 ft. hotel to Paschen Brothers, 111 West Washington St., Chicago. A steam heating system will be installed in same. Total estimated cost, $750,000.

Wash., Spokane—The B. P. O. E. of Spokane has awarded the contract for the construction of a 2 story, 100 x 142 ft. temple on Riverside Ave., to Hurley Mason Co., Gasco Bldg., Portland. A steam heating system will be installed in same. Total estimated cost, $200,000.

Wash., Spokane—St. Luke's Hospital Association, Dean and A St., has awarded the contract for installing a steam heating system, including a 110 ft. stack, to Fred Phair, 416 Second St., Spokane. Total estimated cost, $30,000.

Cal., Los Angeles—Thomas B. Story, Story Bldg., has awarded the contract for the construction of a 13 story, 119 x 153 ft. office and stock exchange building, on Spring St., to Weymouth Crowell, 2026 West 9th St. A steam heating system will be installed in same. Total estimated cost, $750,000.

Cal., San Diego—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for a radio power house to Walter Slater Co., 2314 Santa Fe Ave., Los Angeles, $7500.

N. B., Riverglade—The Department of Public Works, Ottawa, Ont., has awarded the contract for installing a heating plant, etc., in the Jordan Sanitarium, here, to J. H. Doody, St. John. Total estimated cost. $24,547.

Ont., Ford City—The Separate School Board has awarded the contract for the construction of a 2 story school building to Welts & Gray, Confederation Life Bldg., Toronto. A steam heating system will be installed in same. Total estimated cost, $140,000.

Ont., Peterborough—The Board of Education has awarded the contract for installing a heating and ventilating system in the proposed 3 story collegiate institute, to R. C. Sturgeon, Peterborough. $32,145.

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